Construction Methods

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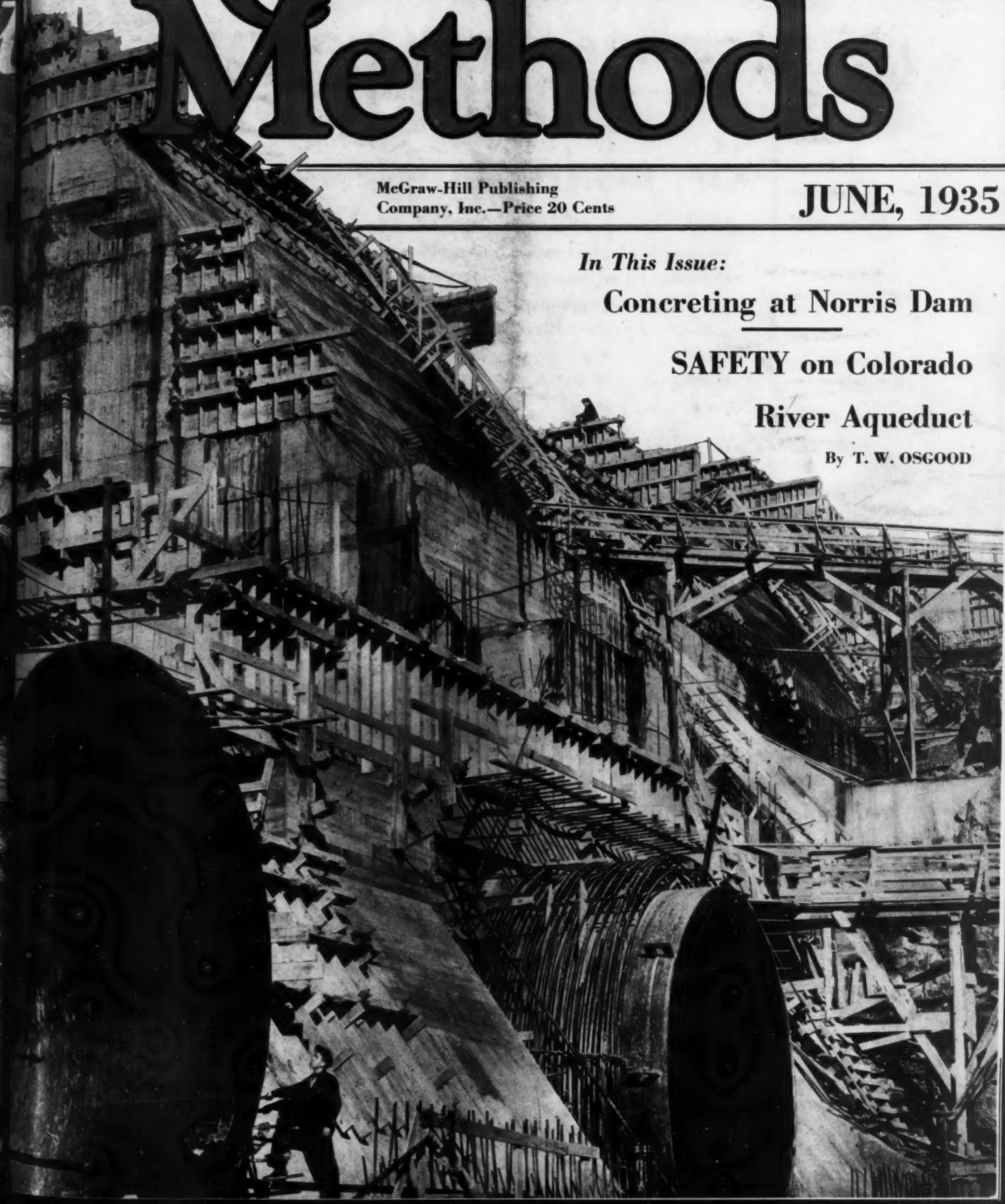
Concreting at Norris Dam

SAFETY on Colorado River Aqueduct

By T. W. OSGOOD



Construction Methods

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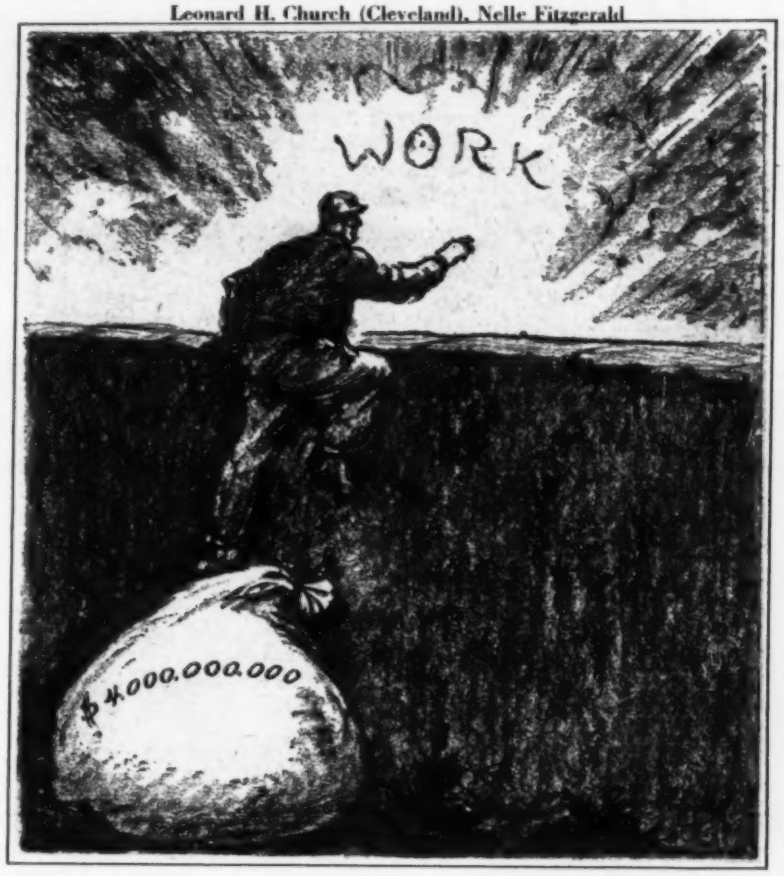

Cassel, in the Brooklyn Daily Eagle

Over the Top!

Organization for Work Relief Program

● For administering the $4,000,000,000 work relief program authorized by the Emergency Relief Appropriation Act of 1935 the President has created three major supervisory agencies: (1) Division of Applications and Information, under Frank C. Walker; (2) Works Allotment Division, under Harold L. Ickes; and (3) Works Progress Division, under Harry L. Hopkins. Supplementing these three overhead units, actual direction of a large part of the vast construction activities will be under the forty or fifty existing government agencies—such as the Public Works Administration, U. S. Bureau of Reclamation, the U. S. Bureau of Public Roads, the Corps of Engineers of the Army and others—which have had experience in administering work of a similar nature. The chief duties and responsibilities of the three key administrative divisions are, in brief, as follows:

The Division of Applications and Information receives, coordinates and passes upon the general desirability of all works projects originating with states, cities, public and private bodies or with Federal departments or agencies, including PWA. After examining into the usefulness of the plans submitted, the division will segregate them to conform with relief areas determined by the number of persons within a proper geographical area. After clearing through this division recommended plans then pass to the Works Allotment Division.

The Works Allotment Division receives lists of projects after they have been studied and checked as to cost, length of time for completion, amount of labor they will absorb from relief rolls and economic justification, by the Government agencies in whose fields they are naturally classified. With this information in hand the Works Allotment Division, with the advice of a board of Federal department heads, will be able to recommend projects, by districts, for approval by the President who, under the law, authorizes the actual allocation of amounts to be expended under the relief Act. After allocations are made they will be transmitted to the various Government agencies responsible for the prosecution of the work. As the works relief program is intended primarily to give employment, projects must be allocated in proportion to the numbers of people on relief rolls within a given work area.

The Works Progress Division will have the responsibility of seeing that the labor employed is drawn from relief lists, determining wage classifications and rates of pay in different regions of the country, purchasing materials through a centralized procurement office, checking on construction progress and insisting on the maintenance of proper time schedules.

Fundamental Requirements

● The President has established the following six fundamental principles to determine the eligibility of a work relief project and its selection with respect to location:

1. The projects should be useful.
2. Projects shall be of such nature that a considerable proportion of the money spent will go into wages for labor.
3. Projects which promise ultimate return to the Federal Treasury of a considerable proportion of the costs will be sought.
4. Funds allotted for each project should be actually and promptly spent and not held over until later years.
5. In all cases projects must be of a character to give employment to those on the relief rolls.
6. Projects will be allocated to localities or relief areas in relation to the number of workers on relief rolls in those areas.

Federal agencies charged with responsibility for carrying on the work program will be called upon to explain any lag in execution. Cancelling of allotments will be the penalty for chronic procrastination.

Wage Rates Fixed by Zones

● The establishment by the President last month of wage rates on work relief projects, following the announcement of the overhead organization for administering the huge program, opens the way toward the goal of giving employment, through the medium of the $4,000,000,000 construction enterprise, to 3,500,000 persons now carried on relief rolls. Ranging from $19 to $94 per month, depending on character and geographical location of employment, the scale is considerably lower than existing industrial rates of pay for comparable service. As a basis for establishing the rates prescribed the country has been divided into four zones (far South, middle South, Central and Northern) and four work classifications (unskilled, intermediate, skilled and professional or technical) have been established. Basic rates in the regions outlined differ and within each region there is a further graduation of pay rates into four subdivisions, depending upon the size of the largest municipality in the county where the work is located.

While the rates are at a level which has called forth vehement protests by representatives of organized labor it is pointed out in the executive order establishing them that they are on a monthly, not an hourly basis, so that the worker will be paid for loss of time caused by weather conditions or job delays for which he is not responsible. It will be recalled that the plan for the work relief program, as originally outlined, carried, as a general policy, the recommendation that compensation on emergency relief projects should be larger than the amount received as a dole but not so large as to encourage the rejection of opportunities for private employment or the leaving of private employment to engage in government work.

Exemptions

● Specifically exempted from the foregoing wage rates are the following four classes of work on which existing rules and regulations governing compensation and hours of work are already in force: PWA projects, on which a three-zone scale is operative; state highway and grade crossing elimination work, on which wages are predetermined by the individual states; Civilian Conservation Corps activities; and Federal buildings, on which prevailing rates are required by the Bacon-Davis act. The Works Progress Administrator, however, is authorized to adjust the rate of pay for any class of work in a region by not more than 10 per cent of the amount specified in the executive order previously referred to and also to determine the maximum hours of work, which are not to exceed 8 hours per day and 40 hours per week. It is further provided that on PWA projects and on the highway and grade crossing elimination programs maximum hours of manual labor shall be 8 hours per day and 130 hours per month.

First Allotments For Work Projects

● The first allotments under the $4,000,000,000 works program, announced last month by the Advisory Committee on Allotments and approved by the President, involved a total of $1,091,802,200 for non-federal projects, including: $500,000,000 to the U. S. Bureau of Public Roads for highway and grade separation construction; $102,186,500 to the Corps of Engineers, U. S. Army for river and harbor work; $100,000,000 for Federal participation in a program of 140 varied projects sponsored by the state of Wisconsin; $249,860,000 for 67 slum-clearance and low-rent housing projects under PWA's housing divisions.

To ORGANIZE for *Further* PROGRESS

BY A unanimous decision the Supreme Court now rules out the NRA code structure including the Construction Code with its numerous far-reaching chapters. Thus the construction industry loses the statutory foundation on which it has been trying to build an integrated structure for its administration.

But all this should be no occasion for emotional outburst from either opponents or proponents of the code. Thoughtful men, with the welfare of their industry at heart, will leave to others all jubilation over the political discomfiture of the administration or resentful reproach that their efforts of the last two years may have gone for naught. They will face the reality that whatever may become of its code, the problems of the construction industry still remain: they will save their breath and energy to deal with those problems.

Right now the job is to take stock of progress to date, to contrive means to conserve it and to lay down a program that will enable us to carry on.

We must accept the condition that we shall have to do this without benefit of federal enforcing power; our accomplishment must depend for the most part on our own effort. Possibly a legislative formula may yet be evolved to provide some measure of governmental support: on this, however, we cannot now rely.

What then has been achieved by the industry during the last year and a half of its code administration?

FIRST of all, many individuals and groups have become conscious, for the first time, of their identity with the construction industry. Under compulsion of the National Recovery Act they have had to sit down and talk out their problems, first with each other and later with the other groups that constitute the industry. Observe that they have had to talk them *out;* not just talk them over. For it has been necessary to think of them in connection with the problems of other groups and of the industry as a whole. In doing this many have come to see for the first time how interdependent they actually are and how impossible it is for any one group to deal single-handed even with its own difficulties.

Moreover, in doing this it has been necessary to define more accurately than ever before the sources of the evils that beset the industry; in formulating and administering the several chapters of the code it has been necessary to devise methods and machinery for dealing with those evils. Here we have learned something about what will not work as well as what will. Most of all, we have developed among the various groups a mutual understanding and a will to cooperate where two years ago distrust and self-sufficiency prevailed. This has been demonstrated most convincingly since the decision in the determination expressed by many who have not liked the codes that the industry must hold the gains it has made under them.

Not the least important of these gains is the fact that the industry at last was compelled to work out a pattern for its integration. Then, too, it has glimpsed the power that it might wield outside as well as within its own ranks by effecting unity along lines similar to those prescribed by the code structure. Now the task is to continue, as an industry undertaking, the effort that was initiated with governmental support.

IN carrying out such a program it now should be possible for the industry to enlist the support of various groups which, although inherently a part of it, could not, for administrative reasons, be built into its code structure. Notable among these are the various investment groups and the many producers and distributors of construction materials and equipment; no one has a greater stake in the sound conduct of construction.

If, under a voluntary organization, the industry may be unable to realize certain objectives that seemed feasible under the federal code system, it still may be able to achieve many of them, while at the same time it can wield a productive influence in many fields outside the domain of the federal codes.

But whatever be the means and the method, the need today is obvious. The construction industry has made its first stride toward the integration it so sorely needs, and its dominant concern right now must be to conserve its gains and to organize for further progress.

Willard Chevalier

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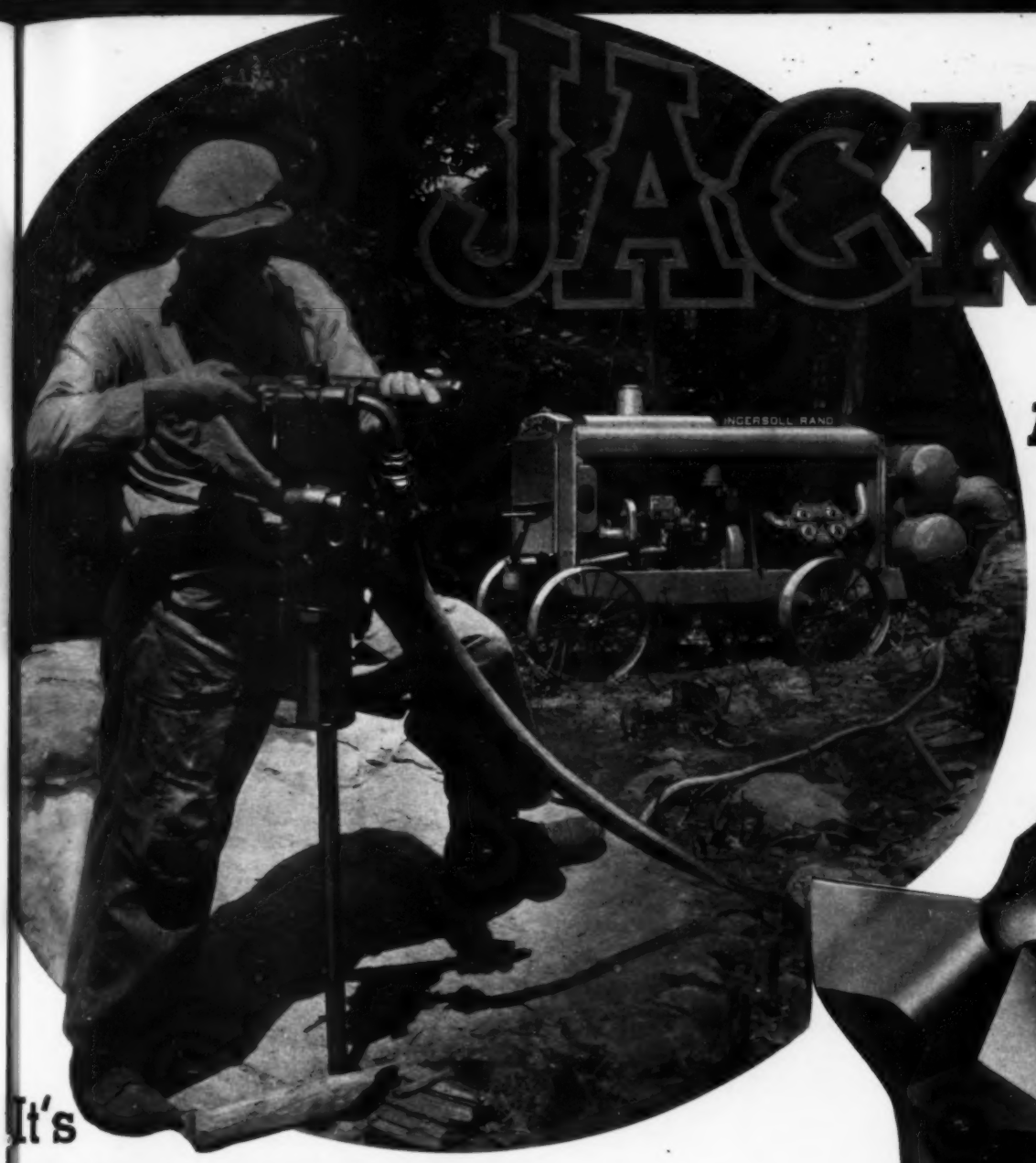
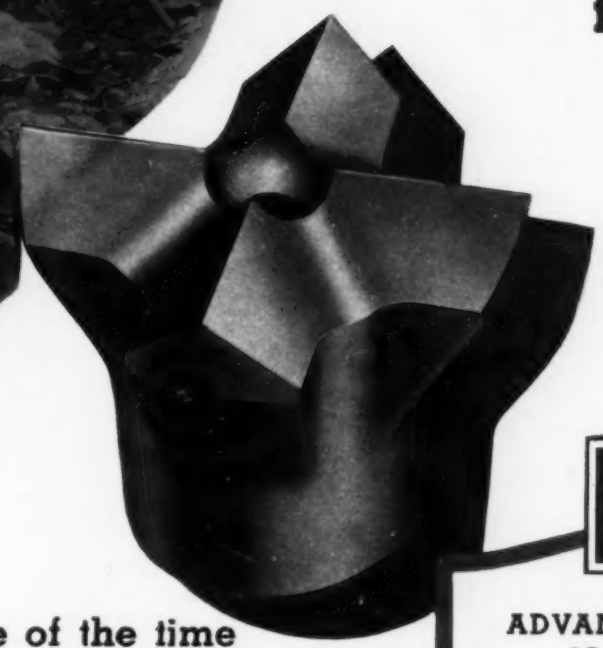


ARE *sharp* BITS

a greater percentage of the drilling time



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166-5

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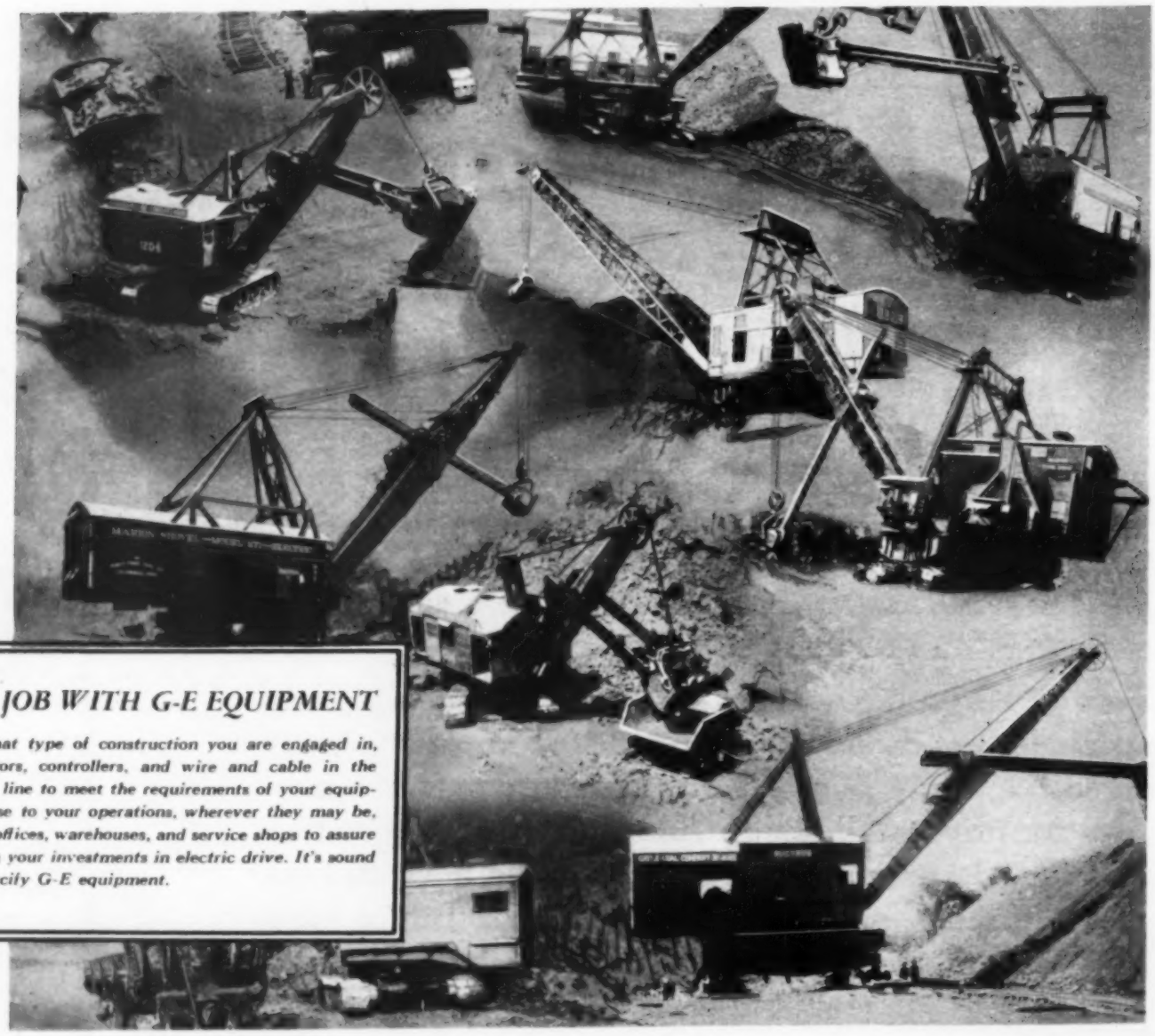

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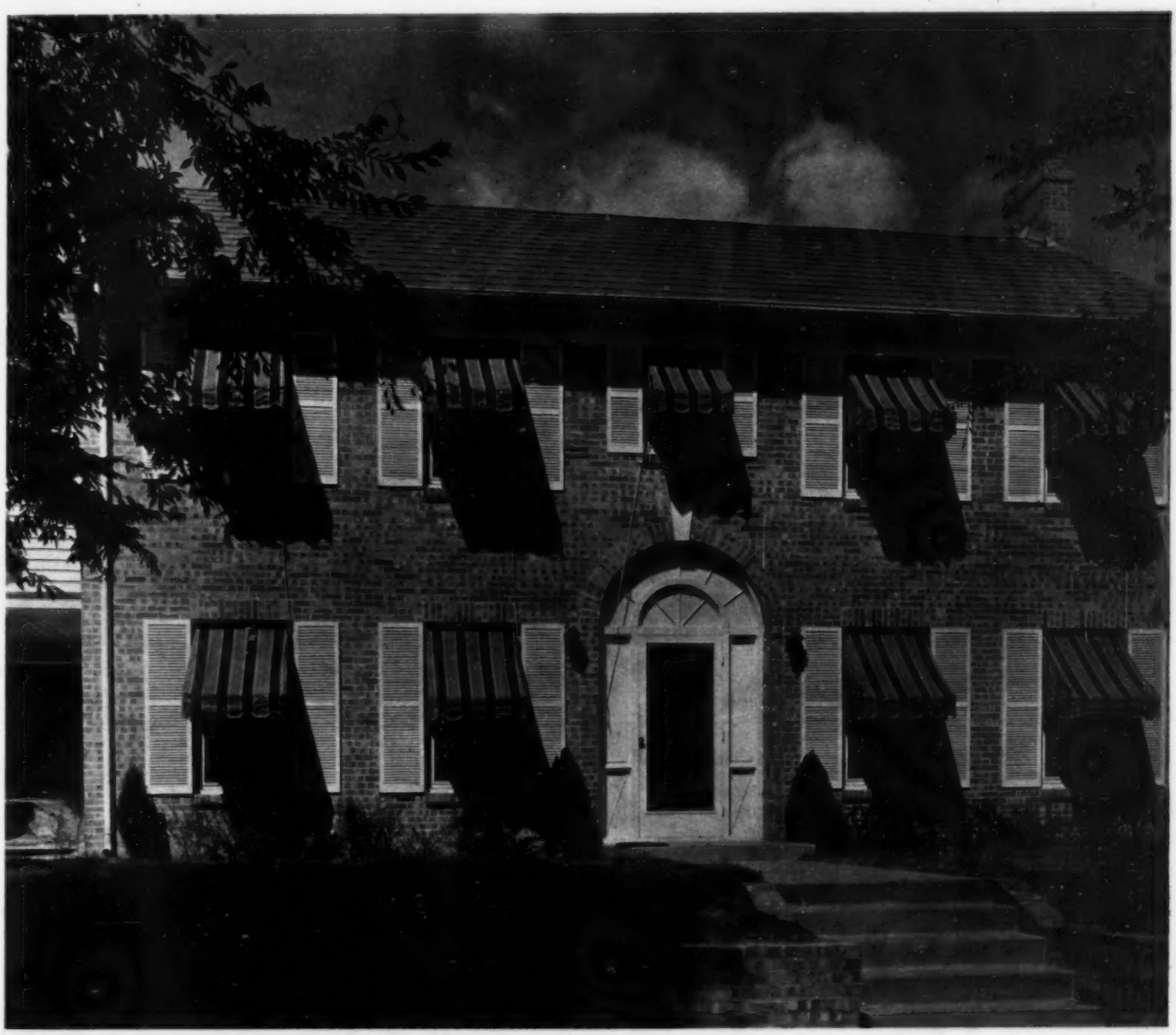
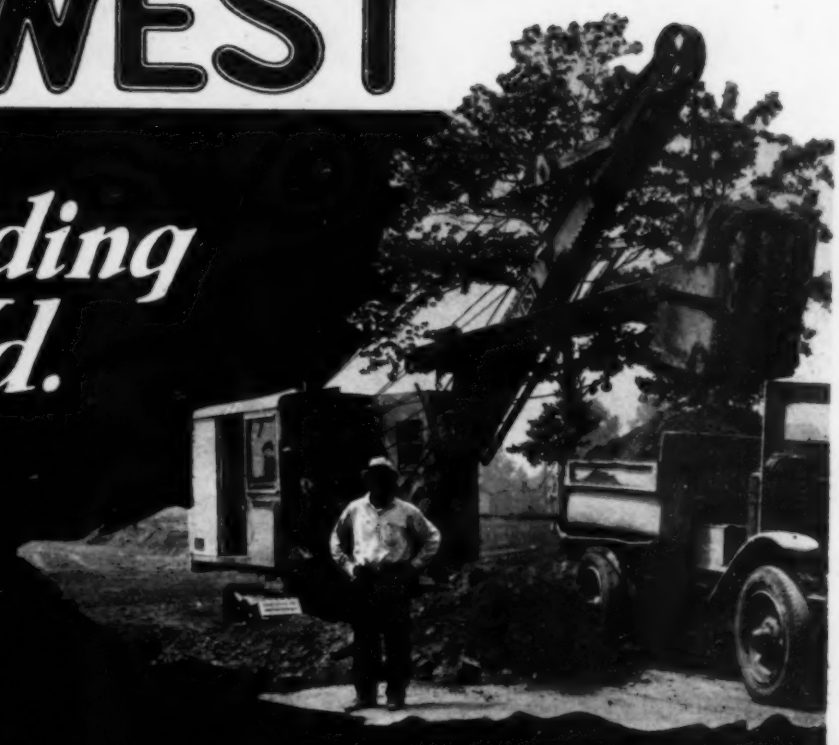


'INCOR' 24-Hour Cement

NORTHWEST



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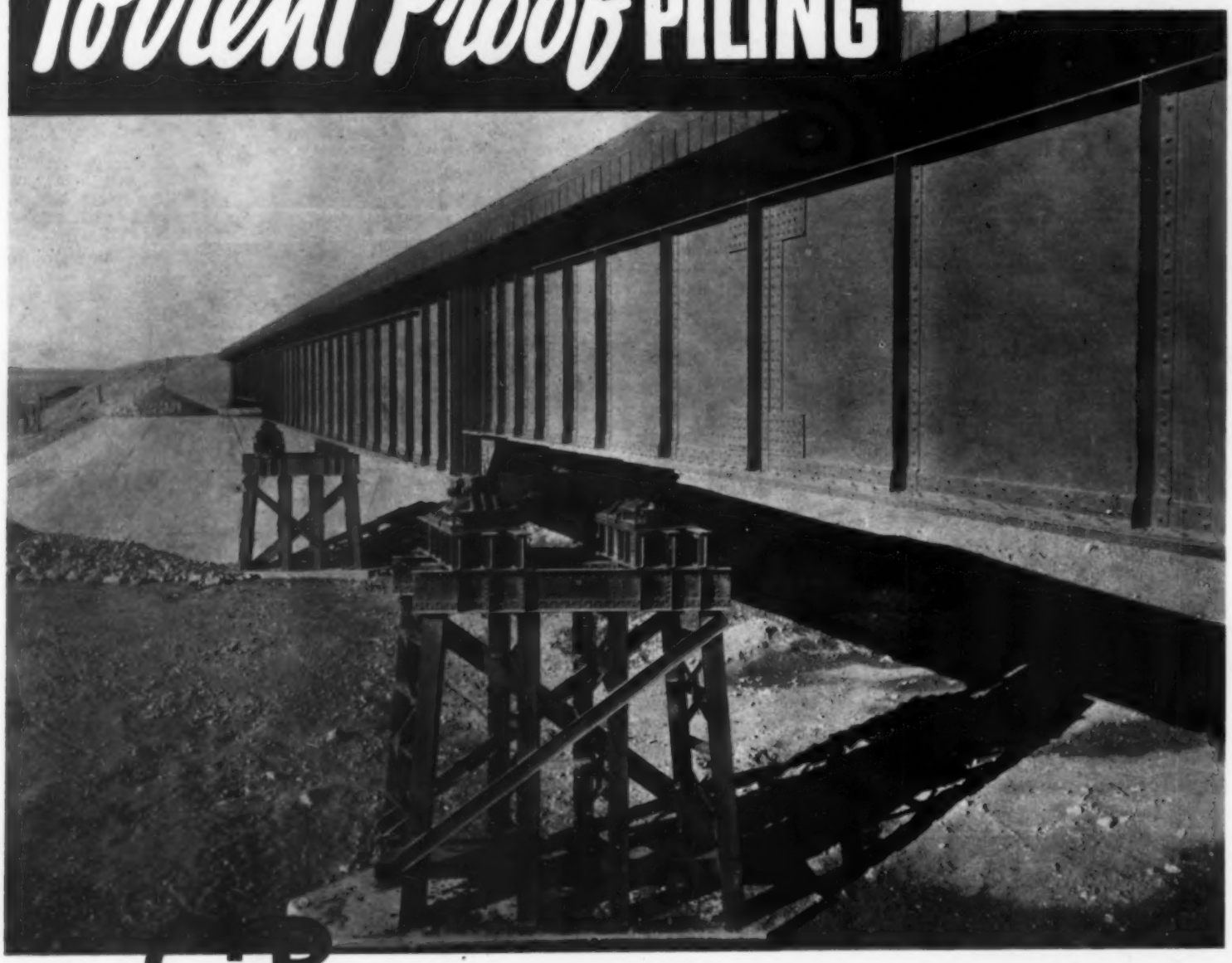

CB
I SECTIONS I

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❶ High load bearing capacity was needed. The piers shown carry a 100-foot girder span and two 70-foot girder spans.

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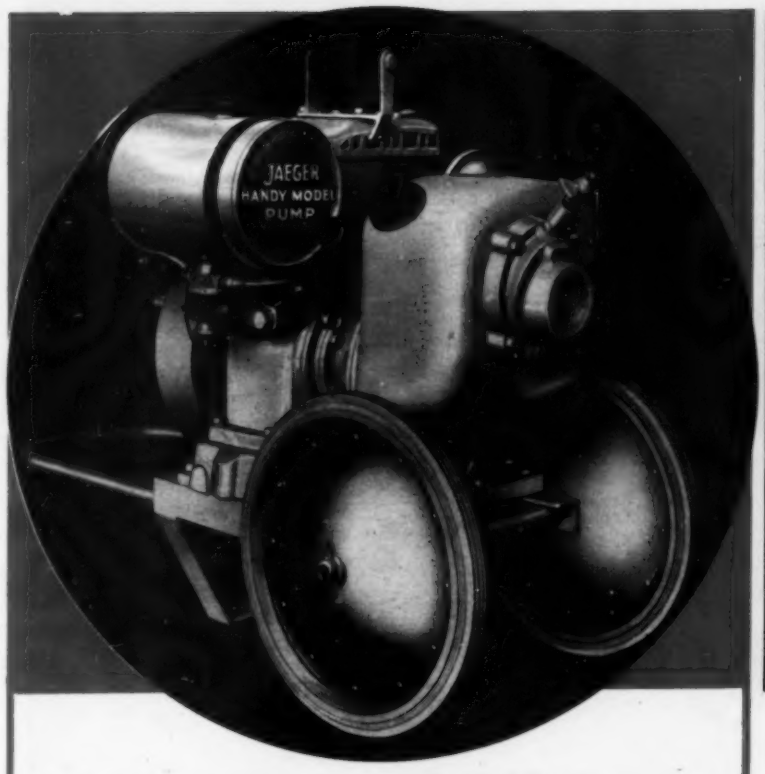

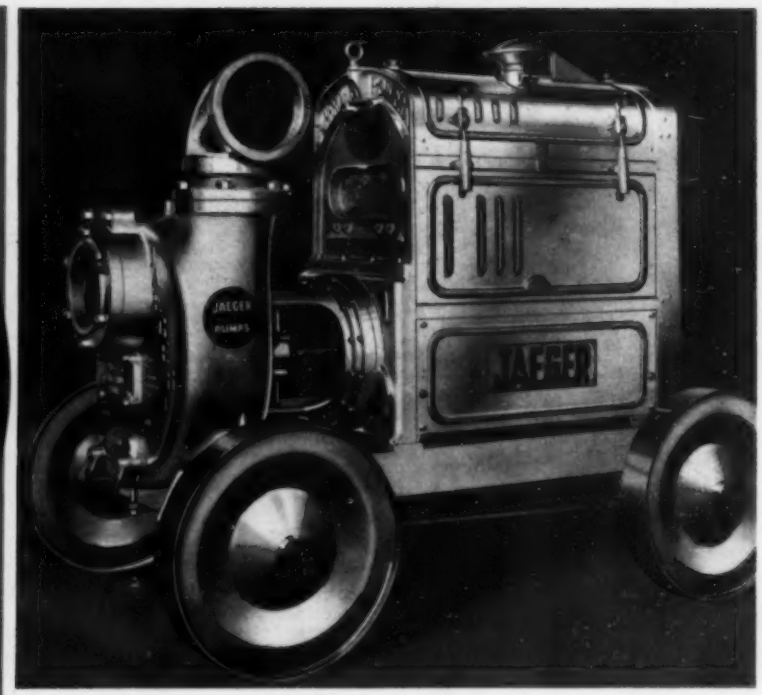

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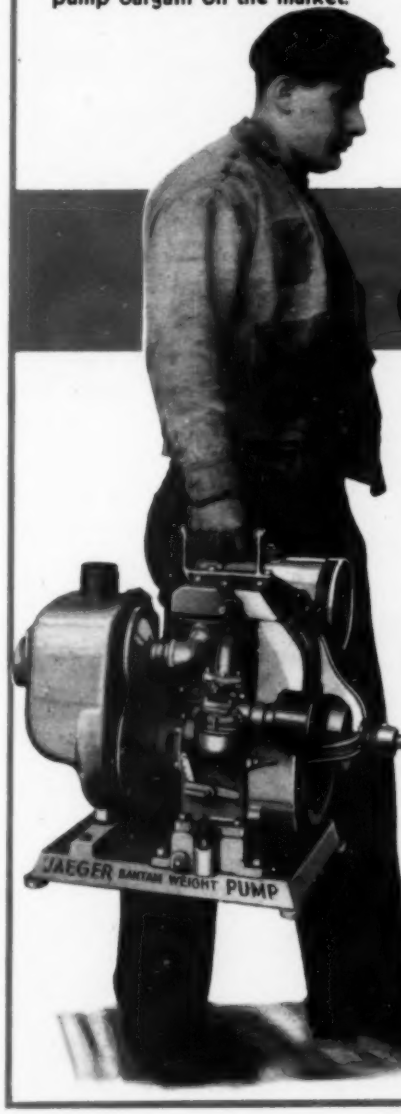

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This truck is the result of years and years of experience by Hug engineers in successfully building trucks to meet special conditions. Such features as the Hug special alloy steel "I" beam frame, the Buda 6 cylinder heavy duty truck engine—the dual drive—double reduction full floating rear axle—the 12 speeds forward, 3 speeds reverse transmission—the set back wheel design with resultant equalized load distribution—make possible the outstanding performance of the Model 99 Hug Quarry Special.

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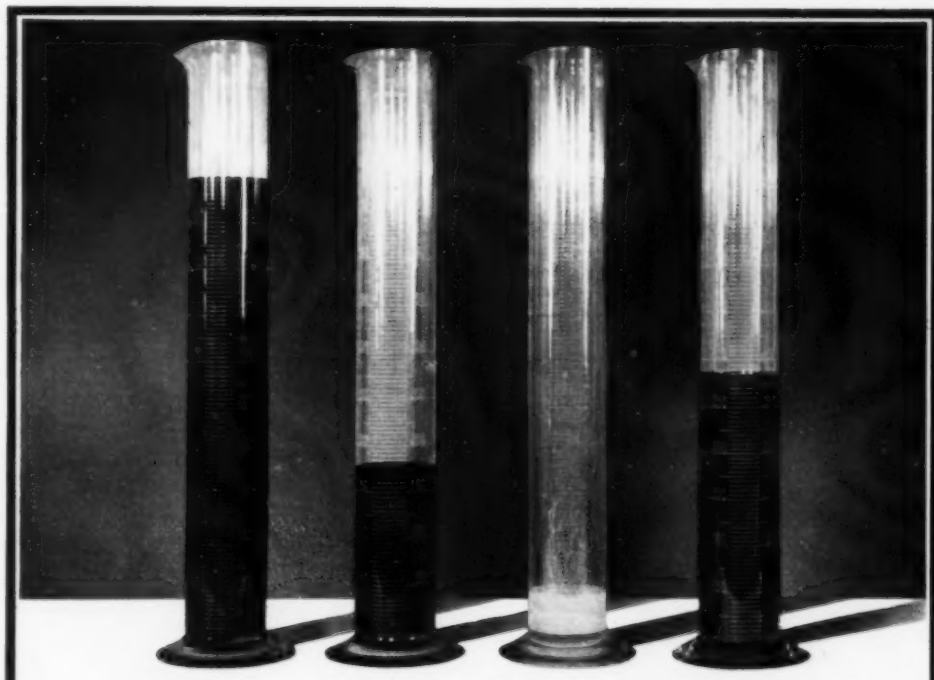
New GULFLUBE MOTOR OIL

Refined by Gulf's Multi-Sol Process



Above is a sample of the original charge of lubricating stock as it goes to the Multi-Sol plant.

Here is the quantity of carbon and sludge forming impurities removed by the Multi-Sol process.

The third test tube contains the solid paraffin wax removed by this efficient refining process.

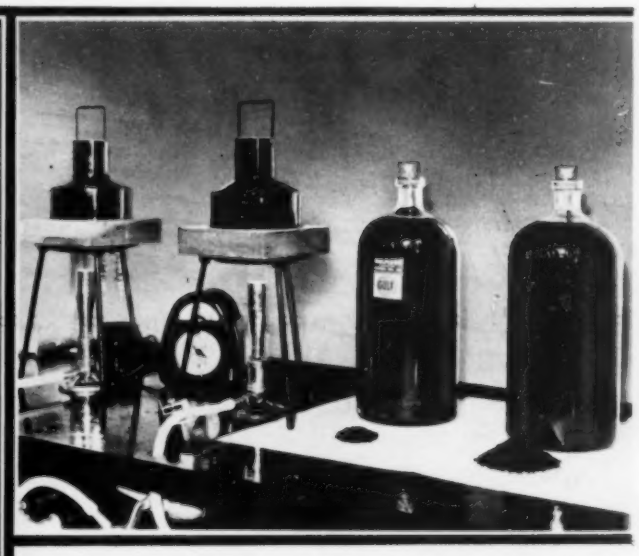
Above is shown the quantity of the pure Gulflube Motor Oil after dewaxing, filtering, etc., secured from the original lubricating stock fractionated from the crude.

Above is a general view of Gulf's new Multi-Sol plant at the Girard Point Refinery, Philadelphia, Pa.

6 REASONS WHY

NO OTHER MOTOR OIL OF ITS PRICE GIVES YOU *ALL* THESE QUALITY POINTS

1. HIGHER MILEAGE—high resistance to oxidation—non-sludging—extra long life.
2. LOW CARBON RESIDUE shows premium quality for paraffinic base oil.
3. EASY STARTING and resistance to heat due to high true viscosity index.
4. ZERO POUR TEST—wax actually removed—no wax crystal poisons added.
5. HIGH FILM STRENGTH—a pure natural mineral oil—no injurious compounds added—will not corrode new alloy bearings.
6. ECONOMICAL LUBRICATION due to these quality points.



The photograph above shows the quantity of carbon that is removed by the Conradson carbon residue test when applied to a gallon of the new Gulflube Motor Oil and a gallon of another widely distributed brand of motor oil.

FLEET OPERATORS CAN NOW USE A PREMIUM QUALITY OIL WITHOUT PAYING PREMIUM PRICE.....

[The new Gulflube is the only motor oil made by this process and sold at 25c per quart at service stations.]

NOW truck and commercial car operators can afford to use a premium quality motor oil!

The new Gulflube motor oil, made by Gulf's Multi-Sol process, is now available to fleet operators at no higher price than they are accustomed to paying for oils refined by less efficient methods.

The Multi-Sol process makes Gulflube *a premium oil in every respect.* In this process, solvents of two opposite actions are used. One action dissolves out the impurities in the lubricating stock refined from the crude oil—tars, gum and carbon forming compounds—and settles them to the bottom of the extraction tanks. The other action selects the desirable parts of the oil and floats them to the top. This selected oil is then "skimmed off," thoroughly dewaxed and filtered —to form the finest motor oil ever offered at its price.

Try this extraordinary new oil in your equipment. You will be pleased with the results.

GULF REFINING CO., Pittsburgh, Pa.

District Sales Offices: Boston · New York · Philadelphia · Atlanta New Orleans · Houston · Pittsburgh · Louisville · Toledo

GULF REFINING COMPANY C.M.-6
3800 Gulf Building, Pittsburgh, Pa.

Please send me complete information and price quotations on the new Gulflube Motor Oil.

Name .....
Title .....
Company .....
Address .....

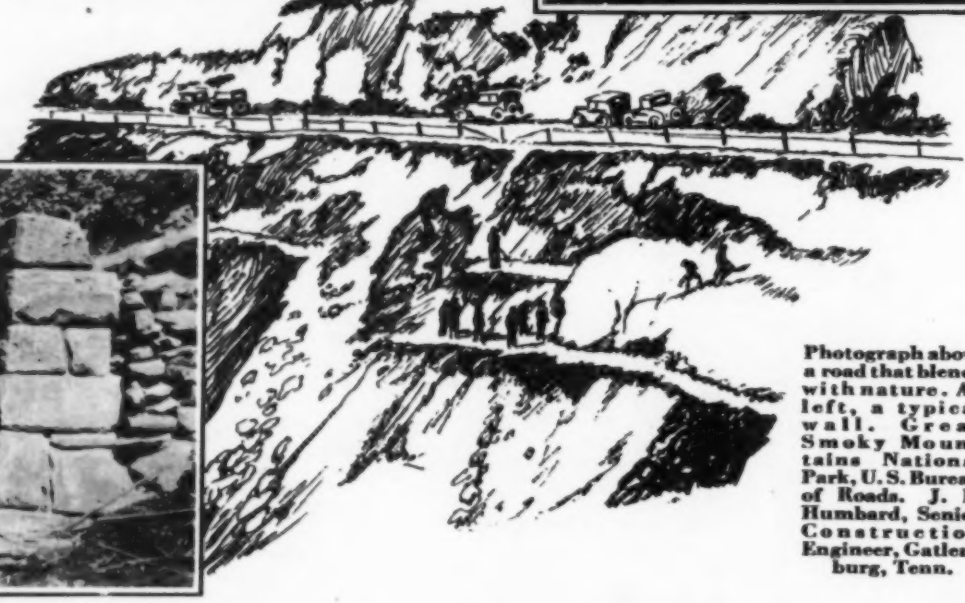
ENGINEERING—ART—AND ATLAS ON NATIONAL PARK HIGHWAYS

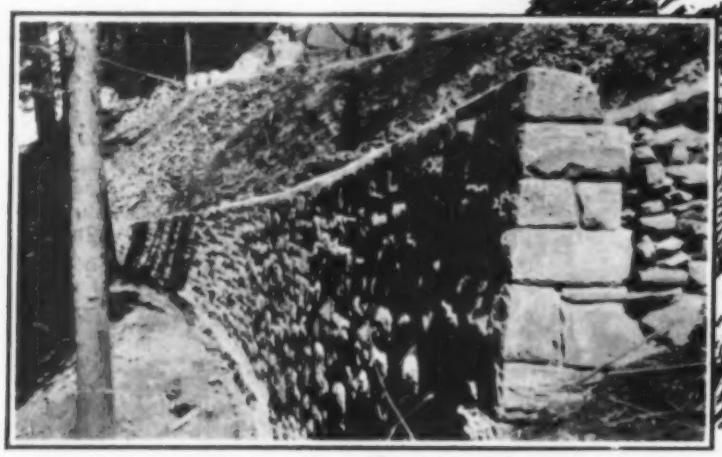
Roads in National Parks are highways which blend with and enhance nature's beauty. Unsightly grades, cuts or embankments are not permitted. Rock fragments must not be thrown or scattered.

Control in every phase of such a highway building project is essential. But in those jobs requiring explosives the control of blasting operations is doubly important.

A project which exemplifies such control, in building a great highway which blends with nature, is now being carried on under the direction of J. L. Humbard, Senior Construction Engineer, in the Great Smoky Mountains National Park. In this, as in many other noteworthy road-building jobs, Atlas Explosives have demonstrated the incalculable value of controlled force.

Let the Atlas representative give you the full facts concerning those explosives best suited to your road-building requirements.





Photograph above a road that blends with nature. At left, a typical wall. Great Smoky Mountains National Park, U. S. Bureau of Roads. J. L. Humbard, Senior Construction Engineer, Gatlenburg, Tenn.

ATLAS POWDER COMPANY, WILMINGTON, DEL.

Cable Address—Atpowco

Everything for Blasting

OFFICES

Allentown, Pa.	Joplin, Mo.	New Orleans, La.	Pittsburgh, Pa.	Spokane, Wash.
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Denver, Colo.	Los Angeles, Calif.	Picher, Okla.	San Francisco, Calif.	Wilkes-Barre, Pa.
Houghton, Mich.	Memphis, Tenn.	Pittsburg, Kansas	Seattle, Wash.	

ATLAS

EXPLOSIVES

THE P&H BANTAM WEIGHT
MODEL 100 3/8 YD

HAS THE PUNCH YOU NEED FOR PROFITS

Watch this new Bantam Weight tear into a job and you'll see the sort of action that turns dirt into dollars. . . . It's full-revolving; weighs only 15,800 pounds in fighting trim — moves fast, climbs easily, turns quickly. And with P&H's Split Second Clutches, Rapid Reversing Chain Crowd and live boom you have a fast digging cycle that can't be beat for accuracy in holding close to grade as demonstrated here. *Powered by Ford V-8 Motor* known for smooth, dependable low cost operation, there's ample reserve for every need. Service is no farther than the nearest Ford dealer; engine can be renewed on Ford Replacement Plan.

A SMALL MACHINE—A BIG PRODUCER

Modern, All Welded Construction has cut off extra weight . . . provided greater strength to take all stresses without faltering. Insures proper permanent alignment of all working parts; lower upkeep expense. High grade alloy steels reduce weight still further. First reduction helical gears, heat-treated and double cut, operate in an oil bath. Anti-friction bearings are used at all vital points. The center of gravity is low with main machinery units mounted behind center pin to eliminate dead counterweight.

Full Convertibility has never before been so simple and economical. The light welded tube boom is strong, easier to handle; makes it practical to convert right on the job for shovel, dragline, crane, hoe, skimmer or pile driver service. Attachments are available at the lowest cost ever known for complete convertibility.

Full Vision Cab has modern streamline design with sliding door and windows; permits unobstructed view of 210 degrees.

For complete specifications. Ask us to mail you a copy.

BULLETIN No. 100

HOW THE BANTAM WEIGHT MEASURES UP:

Capacity	⅜-yard
Engine	Ford V-8 (40 HP)
Weight (as shovel)	15,800 lbs.
Crowding Motion	P&H Rapid Reversing
Clutches	Split Second Control
Swing Clutches	Internal Expanding
Hoist Line Speed	162 F.P.M.
Dragline Speed	162 F. P. M.
Swing Speed	5 RPM
Travel Speed	1½ to 3 MPH
Tail Swing	7 Feet
Height to Top of Cab	10 Feet 4 inches

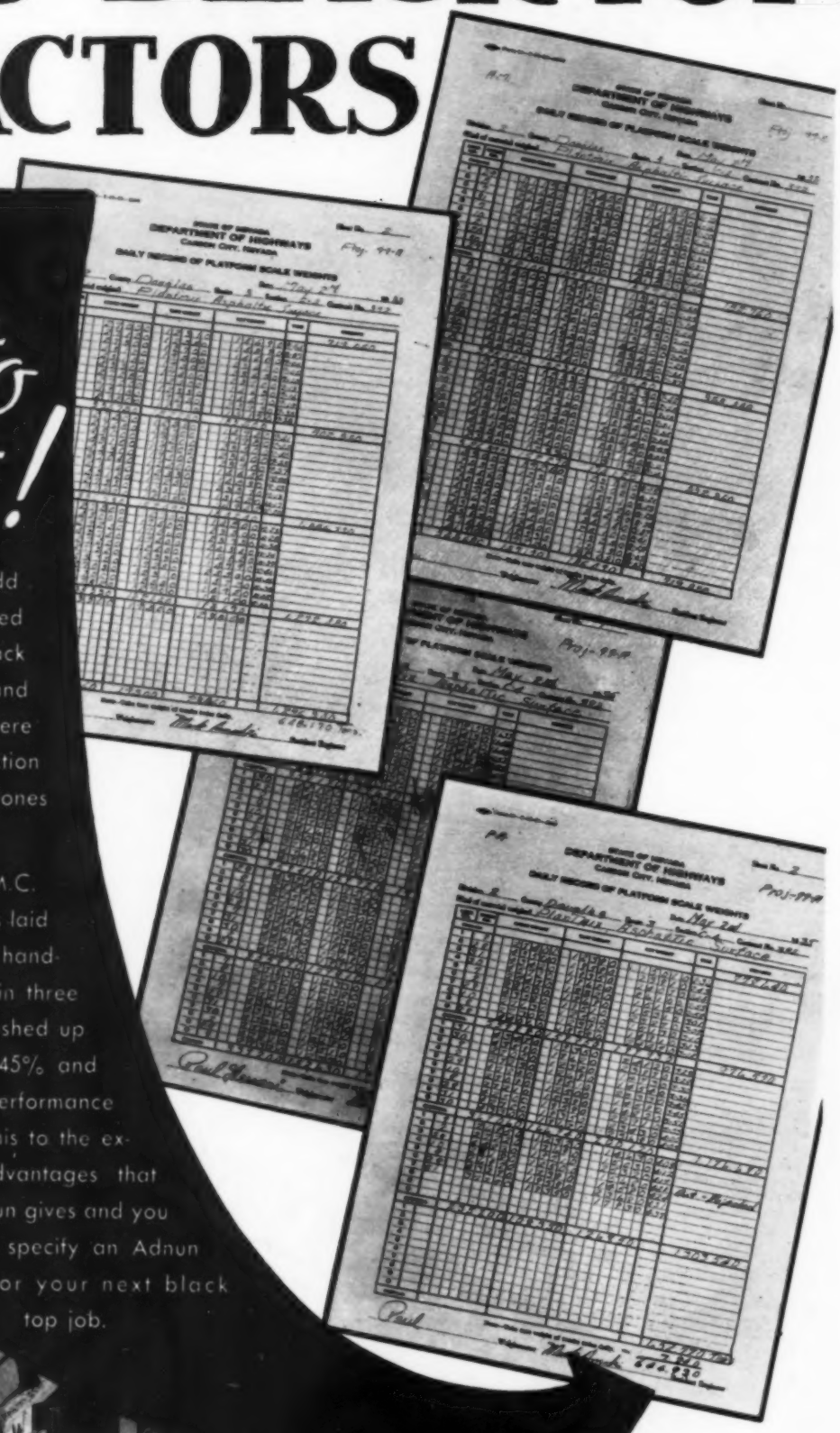
HARNISCHFEGER CORPORATION

4494 W. National Avenue Milwaukee, Wis.

Warehouses and Service Stations: Hoboken Memphis Jacksonville Established 1884 Seattle Los Angeles San Francisco Dallas

Branch Offices in Principal Cities of the World

YOU BLACK TOP CONTRACTORS



here is a record to shoot at!

1294 tons of black top in 10 hours. Add the figure yourself from these signed weigh records—laid by an Adnun Black Top Paver between Carson City and Minden, Nevada. The contractors were Fredrickson & Watson Construction Co., Fredrickson Brothers, and Jones & King.

The pavement consisted of M.C. 4-cut back asphalt and was laid in 10 ft. strips. 12 ton trucks handled the material and, in three cases, these were pushed up grades of 5.9%, 5.45% and 5.26%. Add performance records like this to the exclusive advantages that the Adnun gives and you will specify an Adnun for your next black top job.

THE FOOTE CO., Inc.

The Worlds Largest Exclusive Builders of Road Pavers

NUNDA NEW YORK

ADNUN BLACK TOP PAVER

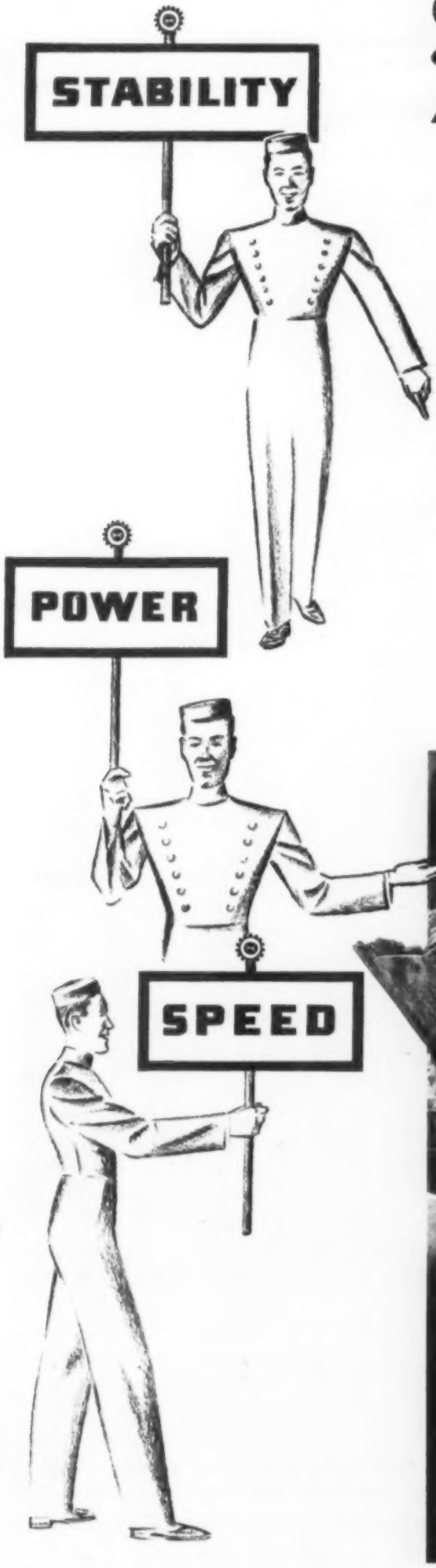
TRADE MARK REGISTERED

State Highway, York Beach, Maine. Tarvia-built in 1913—before the World War—this easy-riding, skid-safe highway is just as satisfactory for 1935 traffic as it was for the automobiles of 22 years ago.

Barrett Tarvia
GOOD ROADS AT LOW COST

For 31 years, The Barrett Company has pioneered in the low-cost road field, developing and improving materials and methods to assure the most miles of smooth, easy-riding, skid-safe road from every dollar spent. With Tarvia, you can build roads to meet immediate needs, and easily and quickly widen or strengthen them as traffic increases. There is a minimum of inconvenience to motorists and property owners, and costs are impressively low. The Tarvia field man will gladly give you the details. Phone, wire or write our nearest office.

THE BARRETT COMPANY New York Chicago Birmingham Philadelphia St. Louis Minneapolis Hartford Detroit Cleveland Boston Buffalo Columbus Milwaukee Providence Syracuse Lebanon Toledo Cincinnati Baltimore Youngstown Bethlehem Rochester Portland, Me. *In Canada:* THE BARRETT COMPANY, LTD., Montreal, Toronto, Winnipeg, Vancouver



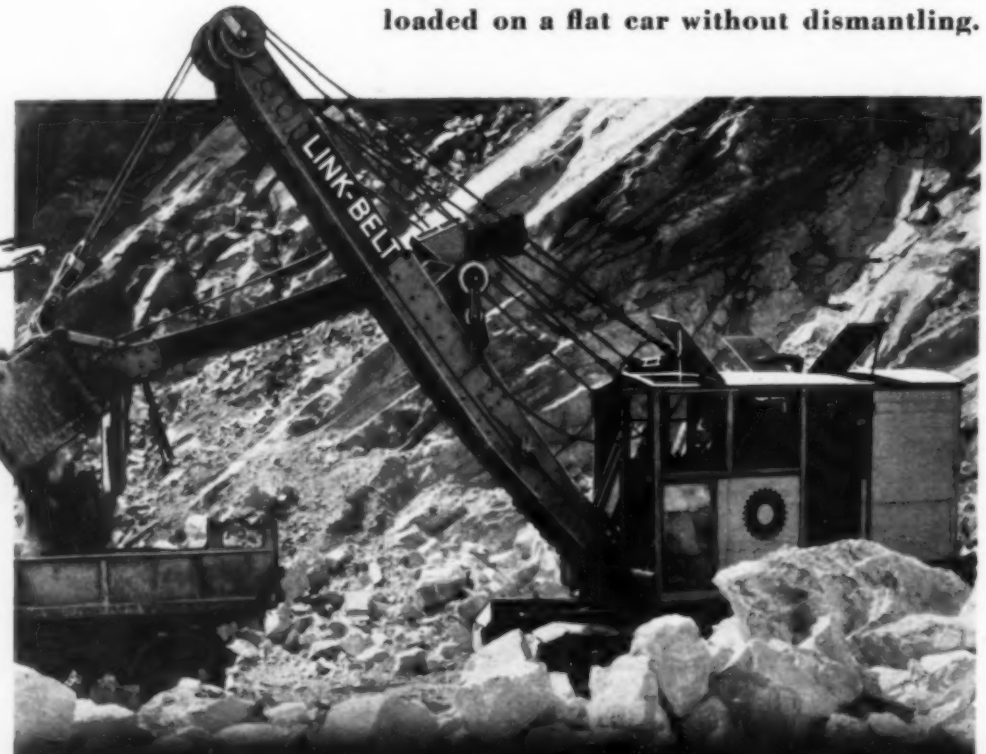
Shows are interesting

BUT THE REAL SHOW IS

"ON THE JOB"

Winning grueling fights against bitter odds builds reputation. The Link-Belt, sound in every part from stem to stern, is a champion on the job. Capable looking on display—a mere indication of its worth in actual use. Only when you see it perform year after year can you fully appreciate its capacity for unexcelled service and compute its true value.

From ¾ to 3 yds. capacity, heavy-duty built. Gas engine, Diesel, or electric motor drive. All models can be shipped loaded on a flat car without dismantling.



LINK-BELT

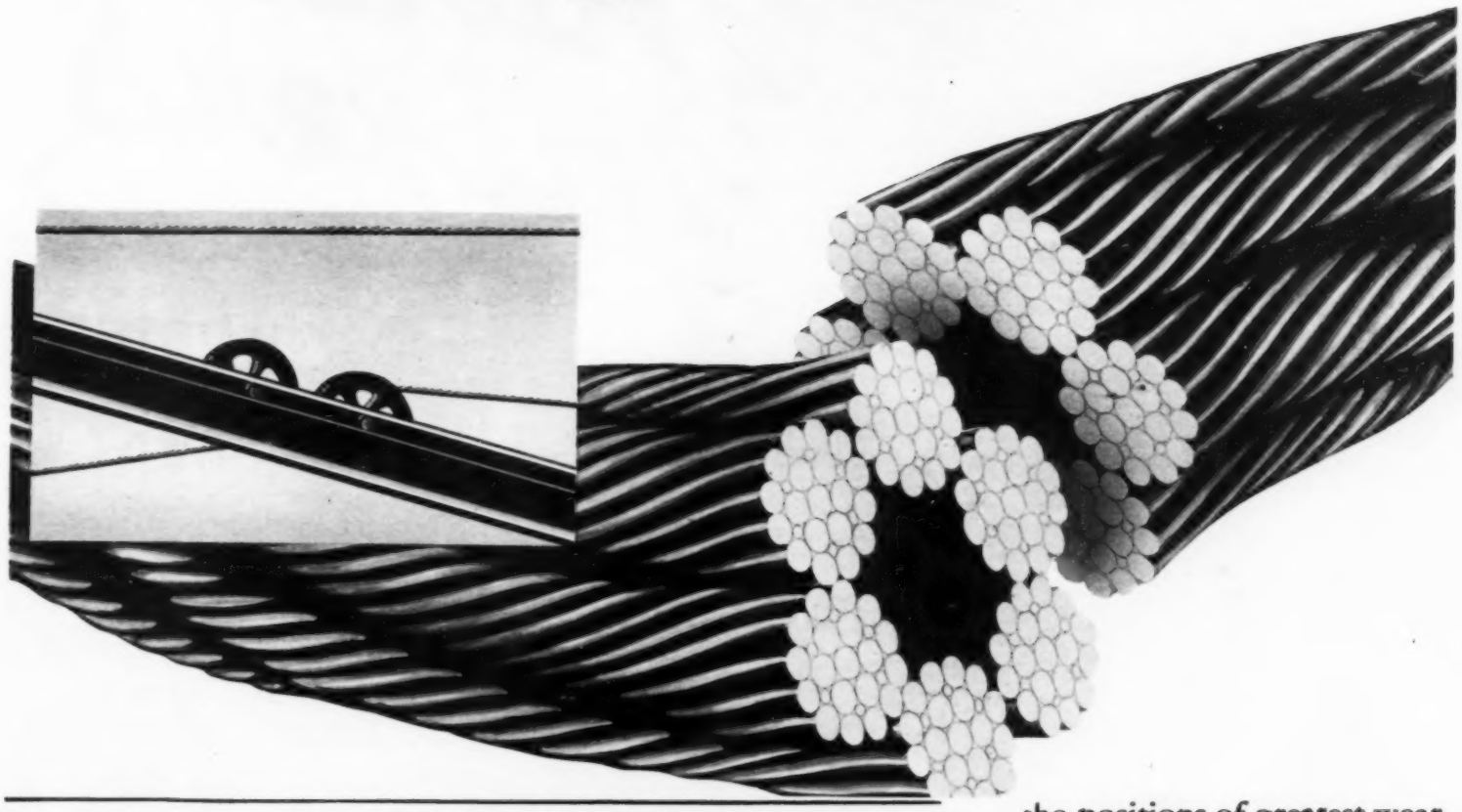
SHOVEL-CRANE-DRAGLINE

LINK-BELT COMPANY, 300 W. PERSHING ROAD, CHICAGO

5136-A

Offices and Distributors in All Principal Cities

Exchange the Ends



Know your Ropes ...This is a helpful hint, how to make wire rope last longer. Subsequent Wickwire Spencer advertisements in this publication will give other dollar saving information. Tell us about your rope problem and we will give you the answer.

Frequently in normal use, most severe deterioration of wire rope due to close bending, occurs near one of the ends. The life of a length of rope so damaged may be materially increased by exchanging the drum end with the load end, thus reversing the rope in use. At the same time worn sections in the remainder of the length will also be relocated and perfect sections exposed to the positions of greatest wear. We will gladly advise you the proper time for reversing the rope based upon your use of ropes. Please write us about it.

•

WICKWIRE SPENCER STEEL CO., New York City; Buffalo, Chicago, Worcester; *Pacific Coast Headquarters:* San Francisco; *Warehouses:* Portland, Los Angeles, Seattle. *Export Sales Dept.,* New York City.

WIRE ROPE
by Wickwire Spencer

BOTH...STANDARD LAY AND WISSCOLAY PREFORMED.

Wickwire Spencer manufactures all sizes and types of Wire Rope in standard lays and preformed. Wisscolay preformed wire rope will often solve a wire rope application difficulty. Ask our engineers where and when it should be used. Send for a free WIRE ROPE BOOK. It will prove of great value.

KOEHRING

Dandie Mixers

7-S 2870 lbs.
10-S 3800 lbs.
14-S 4975 lbs.

The Koehring Automatic Skip-Flow Shaker, shakes the skip perpendicularly, without strains to the mixer. The aggregate moves along the natural flow-line of the skip.

KOEHRING HEAVY DUTY

KOEHRING DANDIE MIXERS, designed for light weight, with ample strength, have every modern feature for fast and convenient operation. Full spring mounting, full anti-friction bearings, automatic skip-flow shaker, short wheel base, silent V-belt drive, are important advantages of these modern mixers.

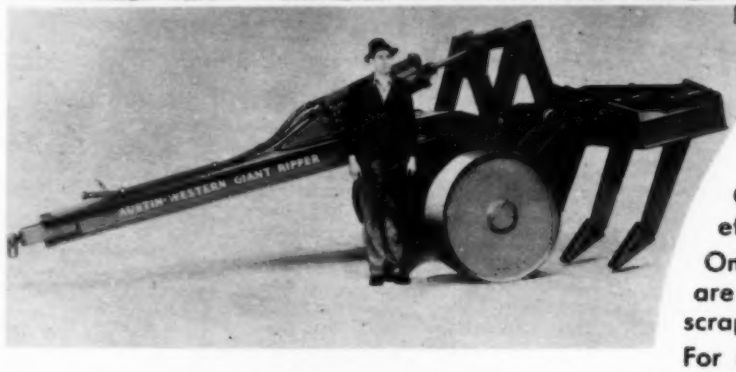
The Dandie Trail-Mix is narrow in width and correctly balanced for hauling or mixing. The obstruction-free charging skip permits fast and easy loading of material.

KOEHRING COMPANY

Pavers · Mixers · Shovels · Cranes · Draglines · Dumptors · Mud-Jacks

3026 WEST CONCORDIA AVENUE, MILWAUKEE, WISCONSIN

LOAD *Control*



● The powerful new Austin-Western Giant Ripper is also hydraulically controlled. At a movement of a valve on the tractor the huge teeth may be forced any desired depth of cut up to 24 inches into the earth or roadway. As the tractor moves the tearing action continues steadily because of the carefully calculated angles and weights at every point of the ripper. At any moment the teeth may be released by hydraulic control.

New Austin-Western 12-YARD SCRAPER

Forces out load for quick complete dumping . . . All hydraulic control

● For thoroughgoing efficiency a scraper must not only dig effectively but discharge the load completely with no lost time.

On the new Austin-Western Scraper both of these operations are accomplished by hydraulic controls driven by a motor on the scraper and operated electrically from the tractor.

For digging, the bit can be set at any desired depth, depending upon the character of the dirt to be moved. In discharging the load, instead of slow gravity dumping, a hydraulic ram forces the load out.

Among the other features of this most effective tool are: wide axle and heavy pneumatic tires to insure steady running and eliminate the danger of bogging—open top for loading with shovel or elevating grader—rigid frame construction and the elimination of cable, bell cranks, etc. Use the coupon to secure complete engineering and performance details.

The Austin-Western Road Machinery Co.

Home Office: Aurora, Illinois Cable Address: AWCO, Aurora

Branches in Principal Cities

The Austin-Western Road Machinery Co.
A-6, Aurora, Illinois

Send details on ☐ the Austin-Western 12-Yard Scraper. ☐ Giant Ripper.

Name.....

Address.....

City..... State.....474

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Austin-Western

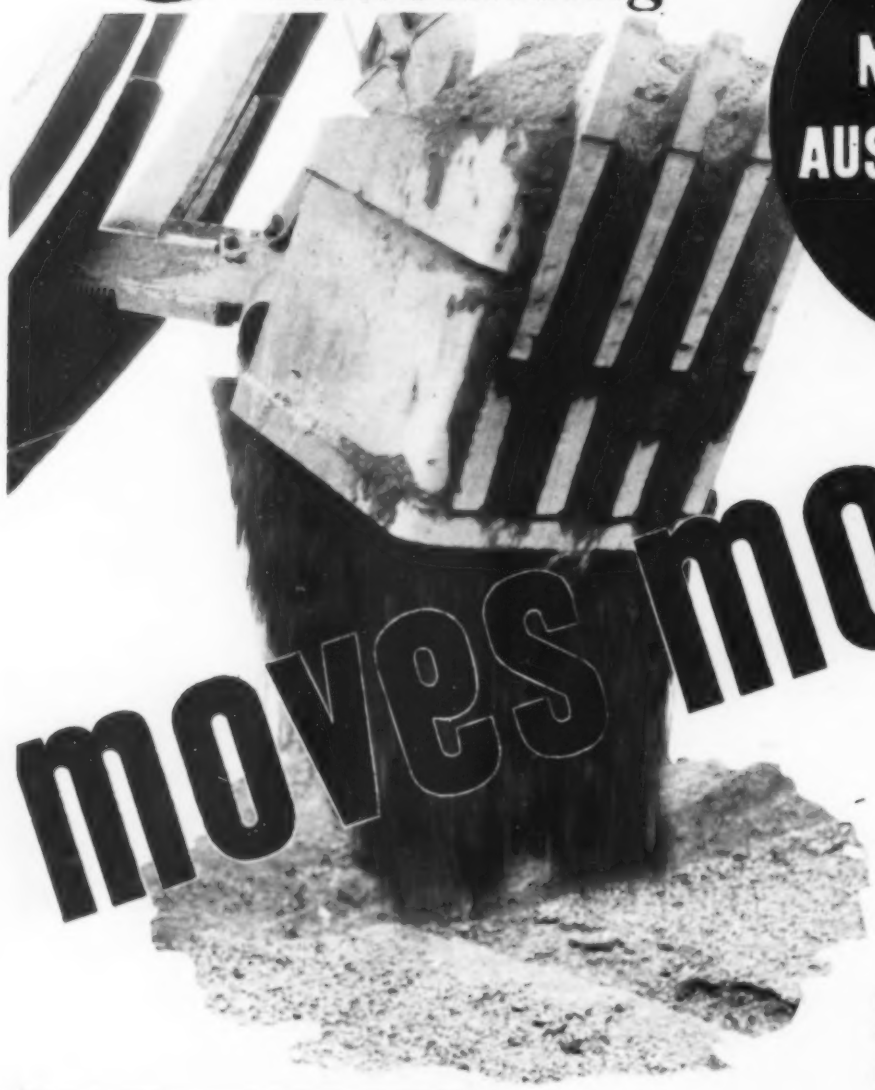
DUMP WAGONS

BITUMINOUS DISTRIBUTORS · ROAD-MIX MACHINES · CULVERTS
SCARIFIERS · BULLDOZERS · TRAILERS · SCRAPERS · PLOWS
DUMP CARS

CRUSHING AND WASHING PLANTS · SWEEPERS AND SPRINKLERS · SHOVELS · CRANES · ETC · SNOW PLOWS

Announcing

A NEW MODEL AUSTIN-WESTERN BADGER



moves more dirt

more power less swinging weight

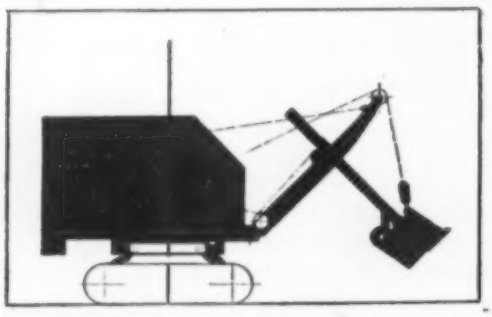
● Speed of operation has always enabled the Badger to compete with larger shovels in capacity per hour.

Those familiar with the Badger's operating principle (see diagram) will readily see how a reduction of dead weight and an increase in the power of the motor has given this new unit a capacity, both in speed of digging and loading, far ahead of any other similar equipment.

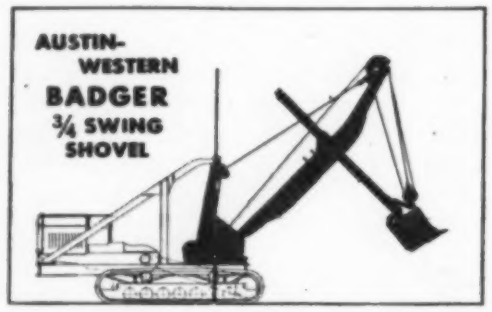
Through the use of alloy steels in boom, dipper stick, and bucket the dead weight of these parts has been reduced. This saving in addition to the increased horse power makes it the ideal tool not only for speed of operation but for rapid transportation and easy handling. Can be furnished with a half-yard bucket at slight extra cost.

Write for details on the engineering features of this machine which make it the big producer at low operating costs.

The Austin-Western Road Machinery Co.
Home Office: Aurora, Ill. Cable Address: AWCO, Aurora
Branches in Principal Cities



The essential difference between these two shovel designs is whether the counterbalancing weight must be moved at every swing or can be used effectively while standing still. Notice that in the Badger the boom is counterbalanced by *idle weight*. Fast starting against minimum inertia and prompt stopping without waste of time and force to brake the momentum are achieved.



The Austin-Western Road Machinery Co.
A-6, Aurora, Ill.
Please send complete information on the new Badger Shovel.
Name.....475
Address.....
City..... State.....

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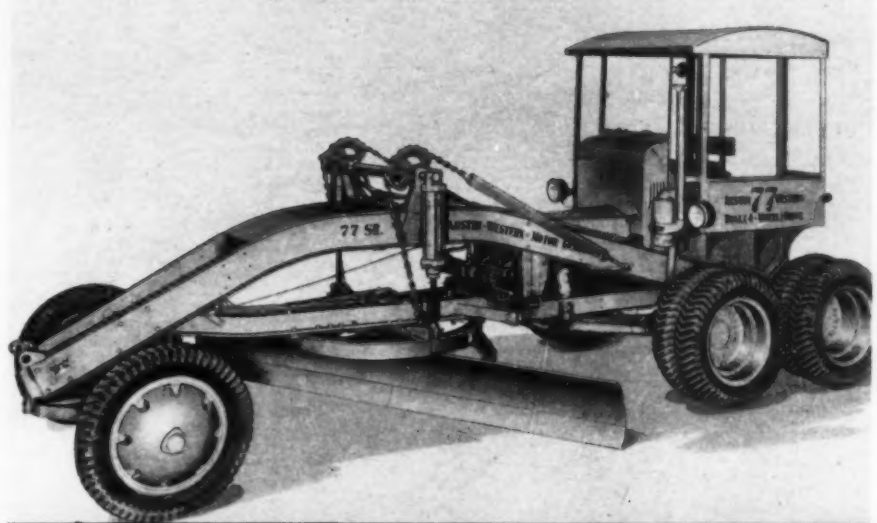
HYDRAULIC CONTROL SAVES 68 WEARING POINTS

Only 1 Rotating Part Compared with the 43 Gears and 25 Universal Joints required to do the same job mechanically.

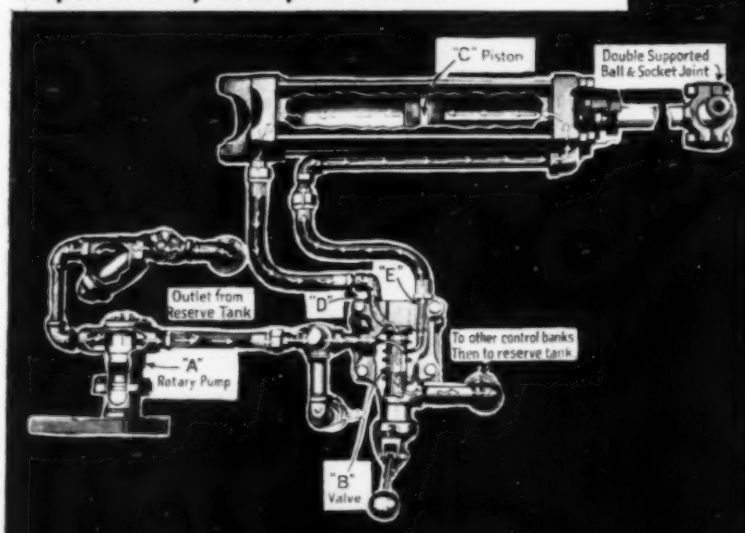
● Meeting this new season's requirements with even greater efficiency, hydraulic steering—the final hydraulic control—has been added to the 77 Sr. .

Hydraulic controls as worked out by Austin-Western bring blade lift, reverse and side shift into better responsiveness to the operator in the cab. They also give the operator a clearer view of the roadway and his blade. Because operation is easier, careful finishing is not shirked. No lost motion with its resultant blade chatter. No power loss from turning over of control gears. A relief valve insures the machine against breakage by a green operator.

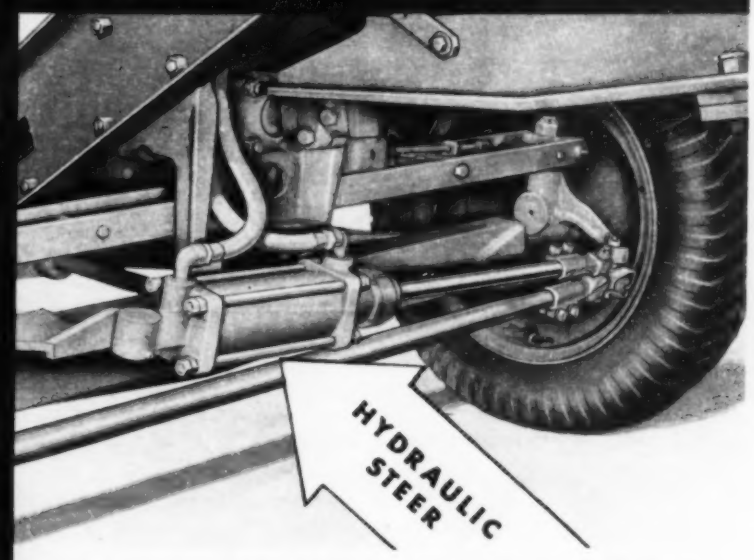
The greatest economy is in lowered maintenance and depreciation costs. Send the coupon for fully descriptive bulletin.



AUSTIN-WESTERN 77 MOTOR GRADER



Oil travels from rotary pump A to sliding shaft B, set to divert the oil into the right hand side of the cylinder, above, causing the piston C to move to the left. Movement forces the oil on left of piston to return to valve B. Valve may be shifted to reverse the flow or placed in neutral, locking the oil on either side of the piston at D and E. When flow is stopped at these points a firm wall of oil holds the piston in a vise-like grip, while oil from pump continues to flow freely through the valve.



No physical effort is required to operate hydraulic steer. A special control valve (in cab) attached to aeroplane-type segment wheel, steers machine in same direction that the wheel is turned. . . . Wide axle resists slippage, handles larger loads and gives stability to entire machine.

The Austin-Western Road Machinery Co.
A-6, Aurora, Ill.

Send full details of the Austin-Western 77 Hydraulic Control Motor Grader.

Name..... 470

Address.....

City..... State.....

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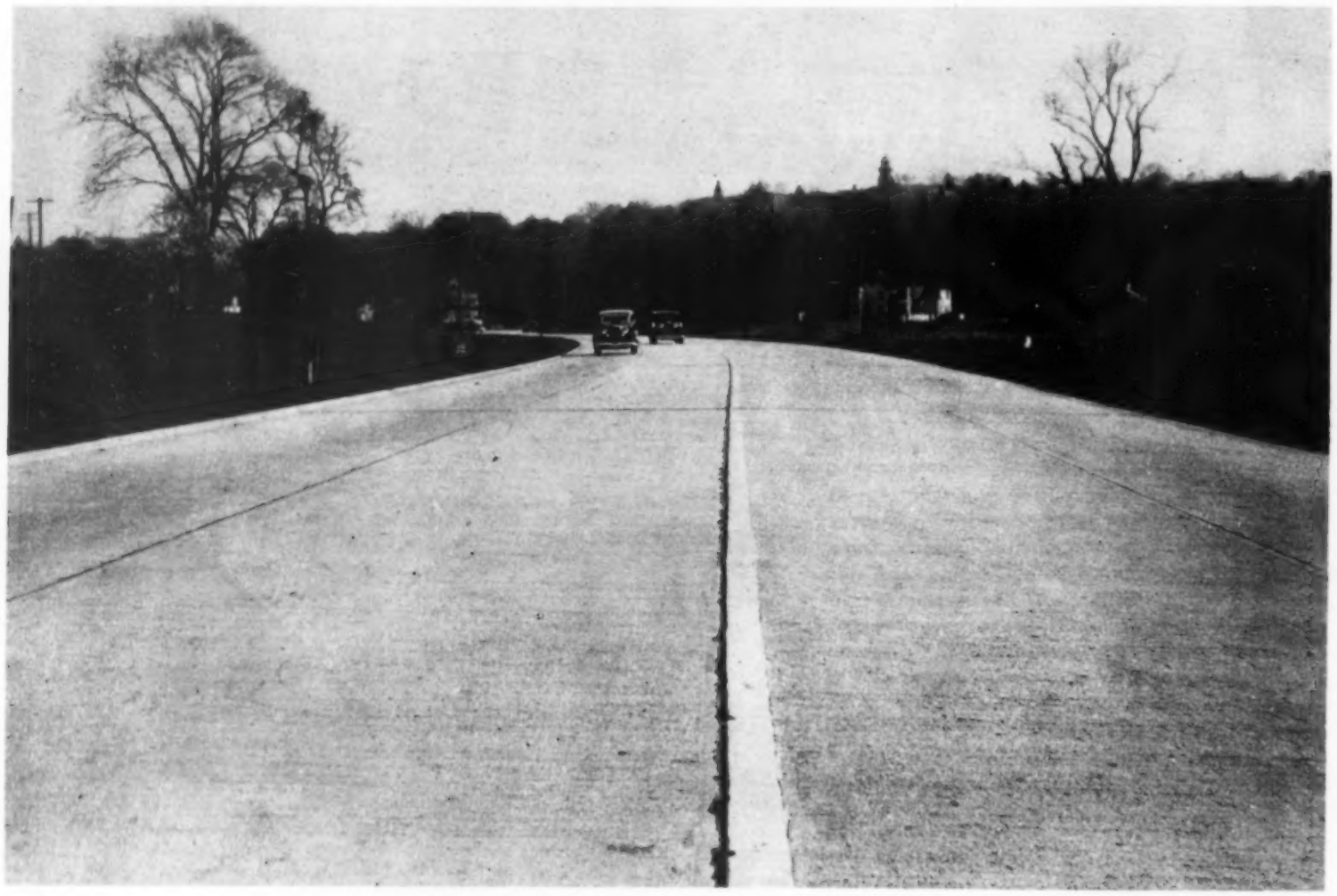
why not SAVE the money you're spending on marker maintenance?



This maintenance-free Atlas White marker, installed in concrete pavement on Central Westchester Parkway in White Plains, N. Y., was built by A. W. Banko, Inc., Hastings-on-Hudson, N. Y., for Westchester County Park Commission. It is 6 inches wide, 1 inch deep, and permanently white.

EVERY dollar spent to replace temporary pavement markers—which traffic quickly wears away again—is a dollar that could be saved.

For the cost of one year's maintenance of temporary traffic markers on a busy street, *permanent* white markers that never need replacement can be installed.

Markers BUILT White

These permanent markers are made of white concrete. They are *built into* the pavement, as an integral unit, and they last as long as the pavement lasts. Installation in new concrete, or brick, or asphalt pavement is a simple job. It is equally simple to place these permanent white markers in old brick or old asphalt pavements.

Markers STAY White

The white surface of these solid white concrete markers is dense, hard and stain-resistant. Neither weather nor traffic can wear these markers away, or blot them out, or erase their permanent whiteness.

No Maintenance Cost

Once these indelible white concrete markers are installed, the expense of marker maintenance is ended. Their first cost is the last cost. And every year after they are placed you save all the money that would have to be spent if temporary markers had to be maintained. Full information will be sent promptly—write Universal Atlas Cement Co. (*United States Steel Corporation Subsidiary*), 208 South La Salle Street, Chicago.

188

ATLAS WHITE TRAFFIC MARKERS

Made with Atlas White Portland Cement—Plain or Waterproofed

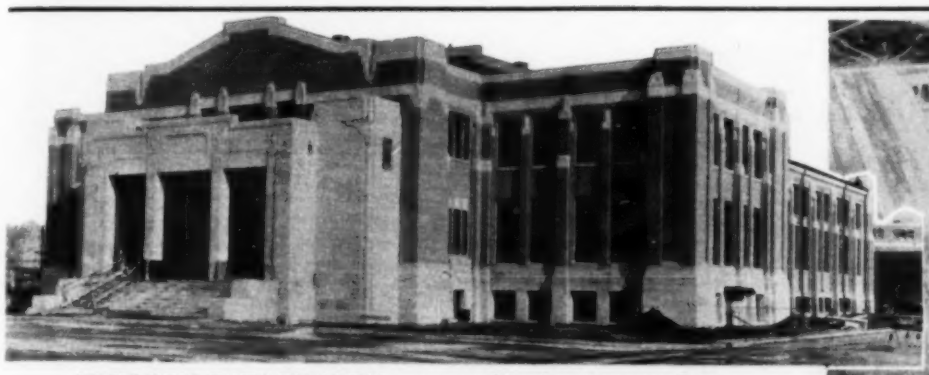
Construction Methods

NRA CODE

ROBERT K. TOMLIN, Editor

Established 1919—McGraw-Hill Publishing Company, Inc.

Volume 17—Number 6—New York, June, 1935



TECHNICAL DATA BUILDING constructed by Quartermaster Corps at Wright Field, Dayton, Ohio, with PWA funds.

NEW HANGARS at Hamilton Field, California, house airplanes and equipment at important coastal air defense station.

Army Handles Biggest

PEACETIME BUILDING PROGRAM

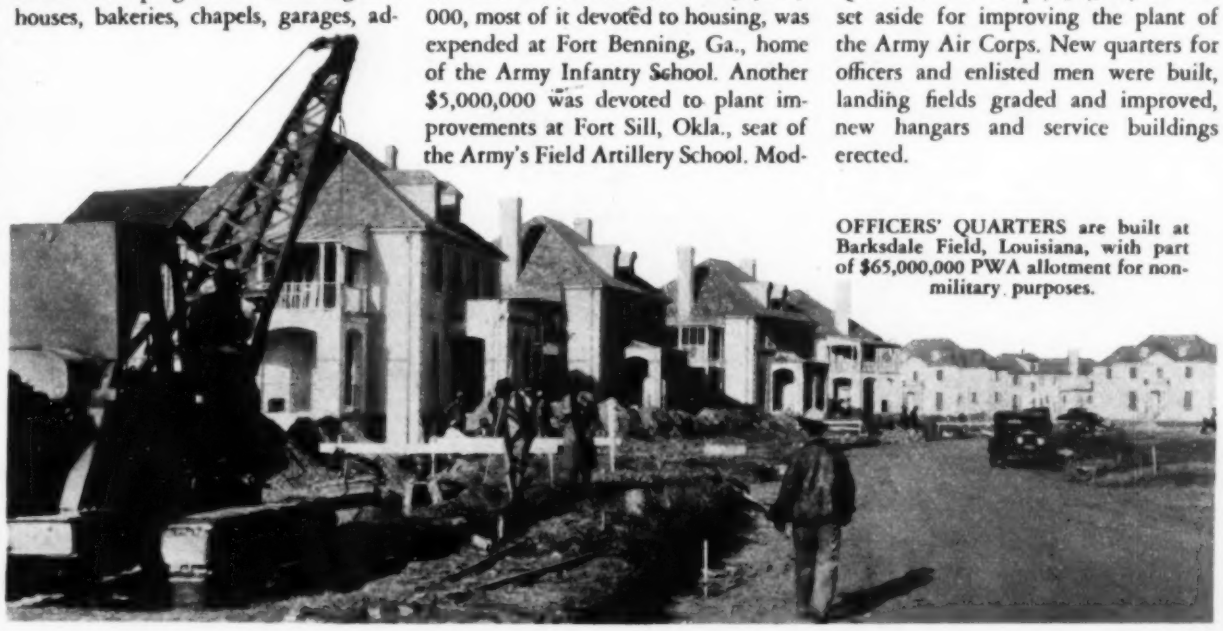
THE GREATEST peacetime construction program in the history of the U. S. Army, enabled by a PWA allotment of $65,000,000 for non-military purposes, is rapidly nearing completion, according to a report made recently to Administrator Harold L. Ickes. Brig.-Gen. P. W. Guiney, chief of the construction division of the Quartermaster Corps., reported that benefits of the program have been spread through 65 stations, posts and camps, located in practically every state. The program has been devoted chiefly to improving the lot of the Army's notoriously ill-housed officers and enlisted men. Peak employment of civilian labor gave jobs to 25,500 men, according to records of the division. Practically the entire apportionment was used for labor and materials; none was utilized for the purchase of land.

With PWA money, the Army has constructed 38 new barracks providing modern accommodations for 6,628 enlisted men. Benefited by these improvements was one regiment of infantry which had been quartered in tents for more than twenty years. Non-commissioned officers were cared for in 353 new buildings containing 490 individual living units. New officers' quarters called for the construction of 800 buildings affording attractive homes for 1,366 officers and their families. Five buildings were erected in as many camps giving comfortable, modern accommodations to Army nurses.

Other types of construction included in the PWA program are fire and guard houses, bakeries, chapels, garages, administration buildings, hospitals and dispensaries, maintenance shops, mess halls, sheds and stables, warehouses and other miscellaneous structures. All in all, approximately 1,600 separate buildings were erected with the PWA allotment, which also paid for the installation of utilities, road and bridge building, railway spur building and other construction.

Some of the most important military stations in the country were enabled to make long needed improvements with the allotment. An allocation of $6,000,000, most of it devoted to housing, was expended at Fort Benning, Ga., home of the Army Infantry School. Another $5,000,000 was devoted to plant improvements at Fort Sill, Okla., seat of the Army's Field Artillery School. Modernization of the testing laboratory for guns and ammunition at Aberdeen Proving Ground, Maryland, where the Ordnance School also is located, was provided for in an allocation of nearly $3,000,000. Other principal improvements included new hangars, warehouses, technical plants and magazines. Yet to be completed is the new 350-bed hospital at Fort Sam Houston, Tex., for which an allocation of $1,900,000 was made recently.

Of the total apportionment to the Quartermaster Corps, $8,300,000 was set aside for improving the plant of the Army Air Corps. New quarters for officers and enlisted men were built, landing fields graded and improved, new hangars and service buildings erected.



OFFICERS' QUARTERS are built at Barksdale Field, Louisiana, with part of $65,000,000 PWA allotment for non-military purposes.

This Month's

"NEWS REEL"

CHICAGO'S WEST SIDE SEWAGE TREATMENT WORKS *(above)*, **recently completed with aid of PWA loan and grant, comprise largest group of Imhoff two-story tanks ever installed. Three batteries of 108 tanks serve area of 100 sq.mi. Plant costing about $20,000,000 provides treating capacity of 466,000,000 gal. daily. Each two-story concrete tank unit is 80 ft. square and 37 ft. deep; tank batteries are arranged in 6 rows of 6 tanks. Contractor, S. A. Healy Co. Chicago. FIRST FLOW OF SEWAGE** *(left)* **into tanks on April 29 is witnessed by engineers and officials of Sanitary District of Chicago, which designed and supervised construction of works under direction of Philip Harrington, chief engineer.**

Inman Photo

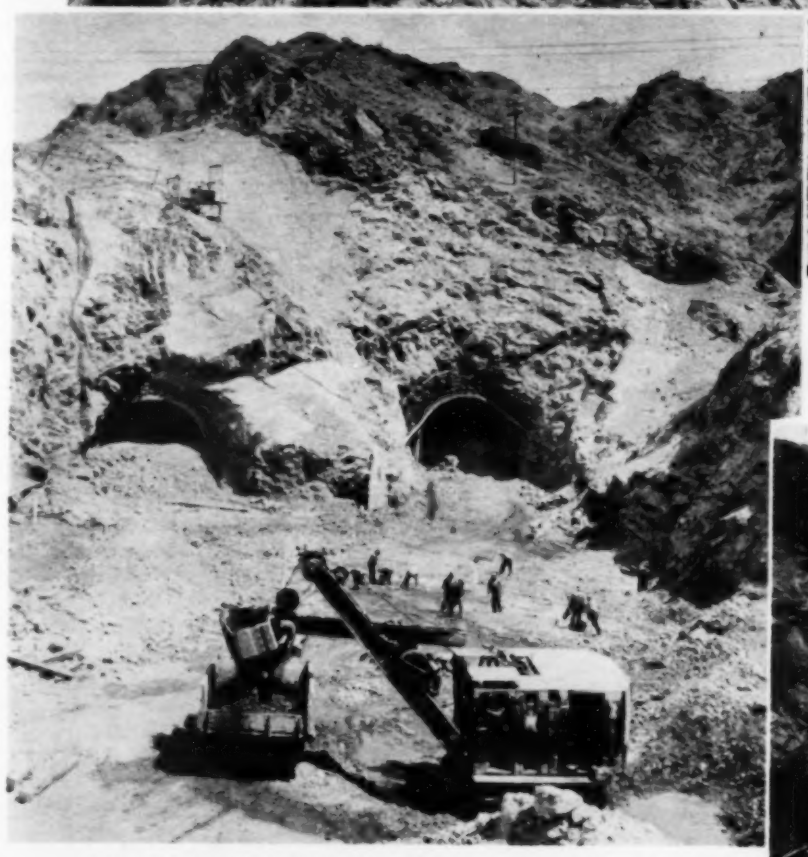
OPEN-CUT CONDUIT CONSTRUCTION gets under way on Colorado River aqueduct in California as Thompson-Starrett Co. builds invert with truck-mixed concrete placed by 4-yd. crane bucket, vibrated and finished with special Lakewood curved-strikeoff machine.

International Photo

ROCKEFELLER SCION REWARDS CRAFTMANSHIP. On completion of Palazzo d'Italia unit of Rockefeller Center building group, New York City, Nelson Rockefeller presents New York Building Congress certificate of merit and gold button to Royal Taft, carpenter, while John Lowry, building contractor congratulates recipient.

MISSISSIPPI RIVER SPANNED by new bridge at New Orleans, La. Structure costing $13,000,000, designed by Modjeski, Masters & Case, consulting engineers, New York, and erected by American Bridge Co., is 23,000 ft. long, including viaduct approaches. Central span is 790-ft. cantilever erected by guy derricks starting at two center piers and working both ways. Bridge will carry both highway and railway traffic. For consultants, C. Glennon Melville is resident engineer.

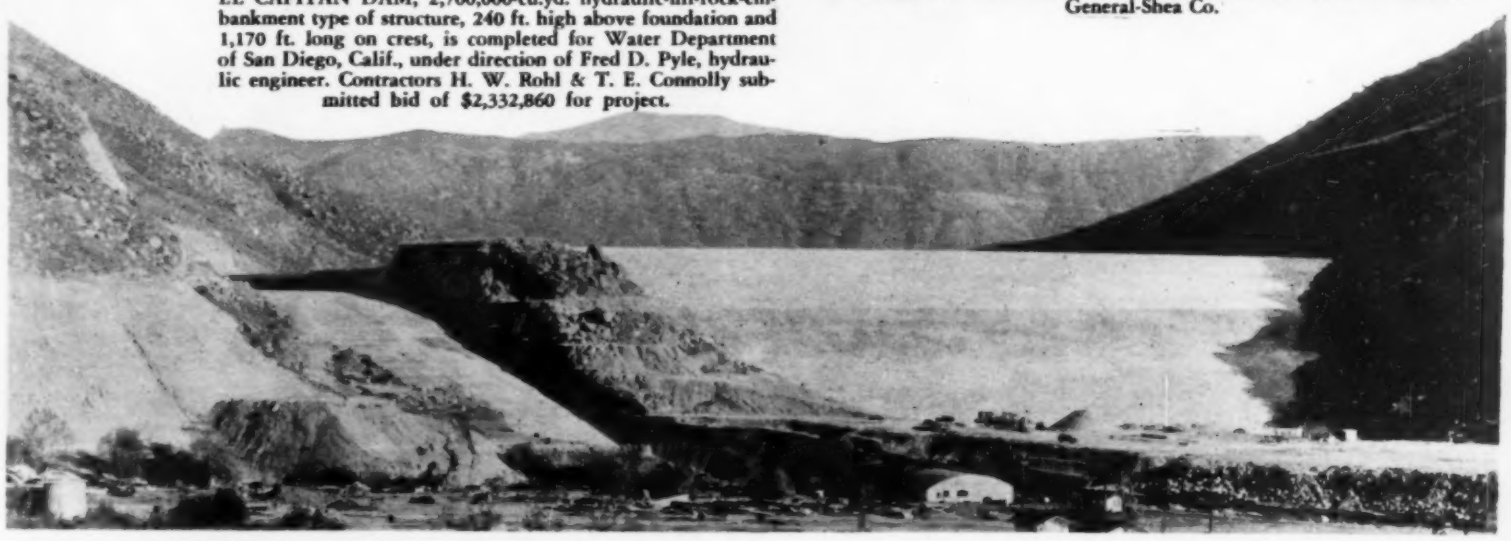
WHEELER DAM, TVA navigation and power project on Tennessee River in Alabama, 15½ mi. upstream from Muscle Shoals, takes form as concrete for structure with overall length of 6,400 ft., including a 2,700-ft. spillway, is placed within huge cofferdam. Dam with maximum height of 70 ft. involves about 500,000 cu.yd. of earth and rock excavation and 600,000 cu.yd. of concrete.



DIVERSION TUNNELS, 29 ft. in diameter, are started at Parker dam on Colorado River to bypass flow around structure which will serve intake of 242-mi. Colorado River aqueduct in California. Dam, designed by U.S. Bureau of Reclamation, will be of concrete arched type, 800 ft. long on crest, raising water 72 ft. above present river level; structure 320 ft. high from base to top penetrates great depth of silt and gravel. Under Six Companies Inc., general contractor, J. F. Shea Co. is subcontractor for diversion tunnels.

LOCK AT BONNEVILLE DAM on Columbia River in Washington is started by placement of concrete within cofferdam. Navigation structure to pass ships, instead of barges as originally designed, is 500x76 ft. in plan, with minimum depth of 27 ft. and lift of 66 ft. Contractor, General-Shea Co.

EL CAPITAN DAM, 2,700,000-cu.yd. hydraulic-fill-rock-embankment type of structure, 240 ft. high above foundation and 1,170 ft. long on crest, is completed for Water Department of San Diego, Calif., under direction of Fred D. Pyle, hydraulic engineer. Contractors H. W. Rohl & T. E. Connolly submitted bid of $2,332,860 for project.



Safety

On the Colorado River Aqueduct

By T. W. Osgood

Safety Engineer

Metropolitan Water District of Southern California

AS AN INHERENT part of the job of building the 242-mi. Colorado River aqueduct, extending from Parker dam, 150-mi. downstream from Boulder dam, to a terminal reservoir near Los Angeles, and including 29 tunnels aggregating 92-mi. in length, the Metropolitan Water District of Southern California, in a determined effort to minimize accidents to construction workers, has adopted and is making effective this policy: THE APPLICATION OF EVERY POSSIBLE SAFETY MEASURE SHALL BE PRACTISED. Splendid cooperation by the construction forces has made possible the good safety record maintained on the aqueduct project, which will involve an estimated cost (including distribution system) of $209,420,000.

Scope of Project—Preparatory and necessary to actual construction of the Colorado River aqueduct, the Metropolitan Water District of Southern California, under the direction of F. E. Weymouth, general manager and chief engineer, constructed and placed in operation 150 mi. of surfaced highways, 428 mi. of high-voltage electric transmission lines, 180 mi. of 5, 6, and 8-in. water supply mains and 285 mi. of telephone lines.

The general features involved in the construction of the aqueduct, which is being prosecuted at present by 20 contractors and 2 District force account units on tunnel and surface work, embrace the following:

Main Line Aqueduct:—Length of canals, 66 mi.; length of conduits, 56 mi.; length of pressure pipe lines, 28 mi.; length of tunnels (diameter 16 ft.), 92 mi.; total length of aqueduct from the Colorado River to the terminal reservoir, 242 mi.;—capacity of aqueduct 1,500 sec.-ft., (approximately one billion gallons per day).

Distribution System:—Length of tunnels, 11 mi.; length of conduits, 7 mi.; length of pipe lines, 126 mi.; total length (initial installation), 144 mi.

Finances:—Aqueduct and distribution system, $220,000,000 bond issue.

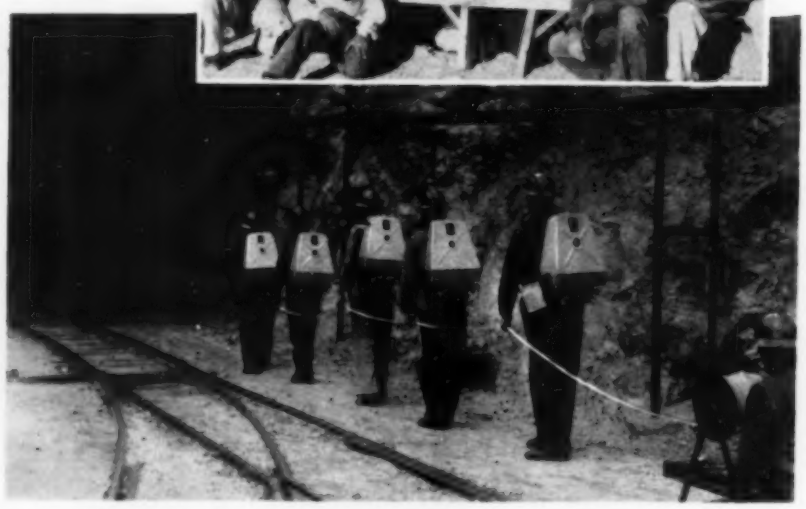
Safety Features—The major safety

1 CONTRACTORS' GENERAL HOSPITAL *(above)* near Eagle Mountain has nursing staff and motor ambulance.

2 SAFETY BULLETIN BOARDS *(left)* are serviced at weekly intervals with posters and bulletins.

3 SAFETY FLAG *(right)* is awarded monthly in inter-camp contest for lowest lost-time accident frequencies.

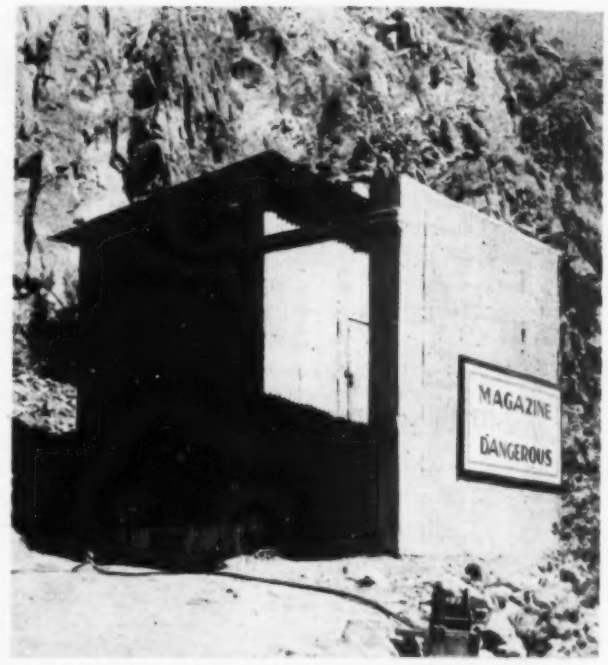
4 MINE RESCUE SQUAD is equipped with truck and oxygen breathing apparatus.



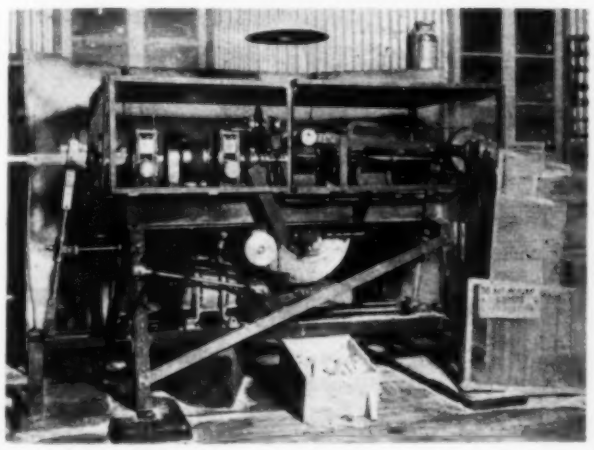
5 PRACTICE MANEUVERS are held to school mine rescue squads in their duties.

6 TUNNEL MAGAZINE provides every possible safeguard for storage of explosives.

7 SAFETY BANNER *(below)* is awarded annually for lowest accident record.



8 HOUSE TYPE OF MAGAZINE for storing explosives has walls, roof and earth-filler 1-ft. thick.



9 MACHINE designed and constructed by District manufactures safety primer plugs; capacity, 4,500 primer plugs per 8-hr. shift.

features along the line of the construction are as follows:

SAFETY COMMITTEES, representative of engineers, employers and employees, hold an average of 30 meetings each month. Ways and means for realizing safe physical conditions and safe practices are discussed and made operative.

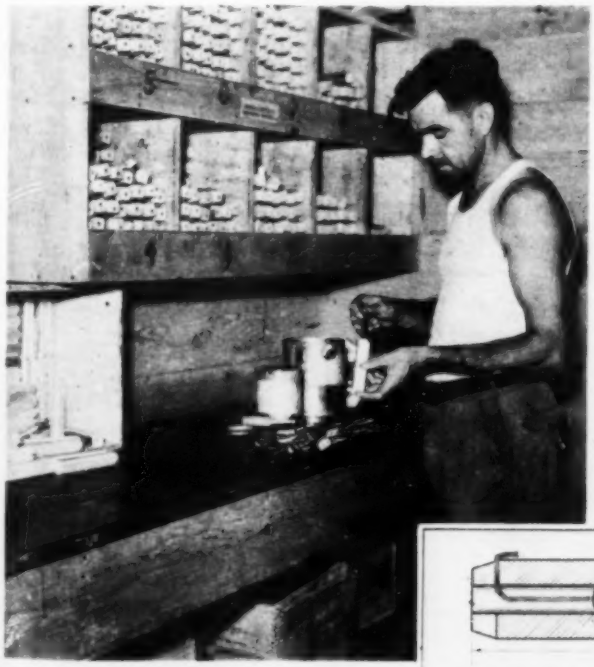
BULLETIN BOARDS (Fig. 2) are serviced with safety posters and safety bulletins at weekly intervals.

SAFETY LITERATURE, published by the U. S. Bureau of Mines, the National Safety Council and other recognized authorities, is made available to the construction forces.

FIRST-AID TRAINING has been conducted annually in the aqueduct camps by the U. S. Bureau of Mines and additional training has been carried on by attaches of the Safety Division of the Metropolitan Water District and of compensation insurance companies. Voluntary attendance of the men at these classes has been gratifying and in a number of the camps 100 per cent of the personnel took this training. Intercamp first-aid contests are held and prizes (Fig. 18) are awarded to the winners.

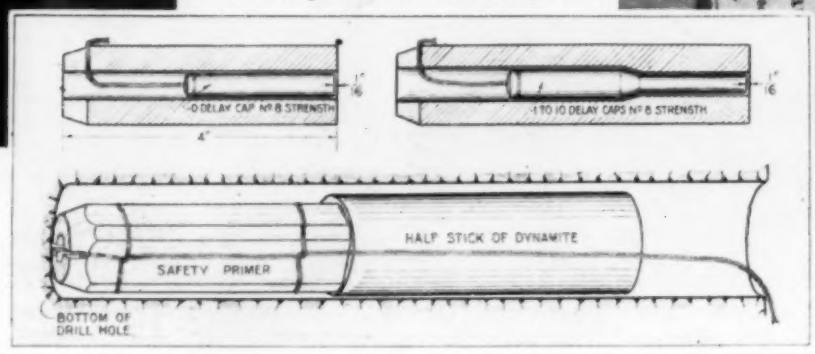
The knowledge acquired through

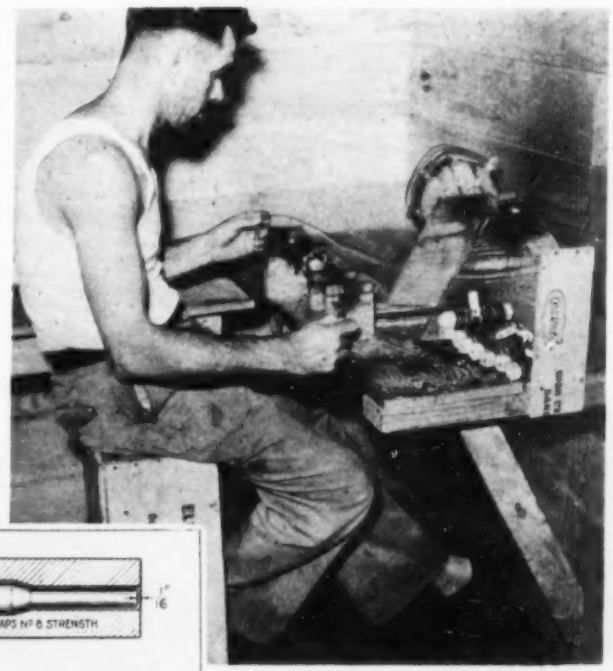
10 TWO-COMPARTMENT CARS for transport of explosives separate dynamite and primers.



11 SAFETY PRIMERS for blasting in tunnel heading are made up in special magazine.

13 DESIGN OF SAFETY PRIMER *(below)* of which more than one-half million were fired with satisfactory results between June 1, 1934 and March1, 1935.





12 PRIMER MAKE-UP MAGAZINE, showing device for winding cap wires on primer plugs.

first-aid training has been put to good purpose in cases of emergency, but it is believed that the greatest benefits lie in the understanding which the men get of the consequences of injuries. This has made them more safety-minded and more diligent in protecting themselves and their co-workers from injury.

Inter-camp safety contests are a continuous feature of the safety work. Monthly and annual awards (Figs. 3 and 7) are made on the basis of the lowest lost-time accident frequencies.

A similar banner was awarded to Shofner & Gordon, contractors, Hayfield Tunnel No. 2, for the lowest lost-time accident frequency in tunnel driving operations at the 29 aqueduct camps —a 1934 record.

ACCIDENT STATISTICS, records of causes, frequency, severity and cost are compiled and these data have served as a valuable guide and stimulus to accident prevention.

A MINE RESCUE station is maintained by the District under the direct supervision of the Safety Division and consists of an inclosed truck, ten sets of McCaa oxygen-breathing apparatus and appurtenant mine rescue equipment. Six 5-man rescue squads (Figs. 4 and 5) trained by the U. S. Bureau of Mines, are kept intact. This rescue unit is available at any time in case of a tunnel fire or other major emergency at any point on the aqueduct.

EXPLOSIVES. Approximately 18,000,000 lb. of explosives will be consumed in blasting the 92 mi. of tunnels through the mountains, and additional quantities will be used in connection with the construction of canals, pipe lines and other surface units.—Every possible safeguard is thrown around the storage, transportation and use of explosives.—(Figs. 6, 8, 15 and 16)—

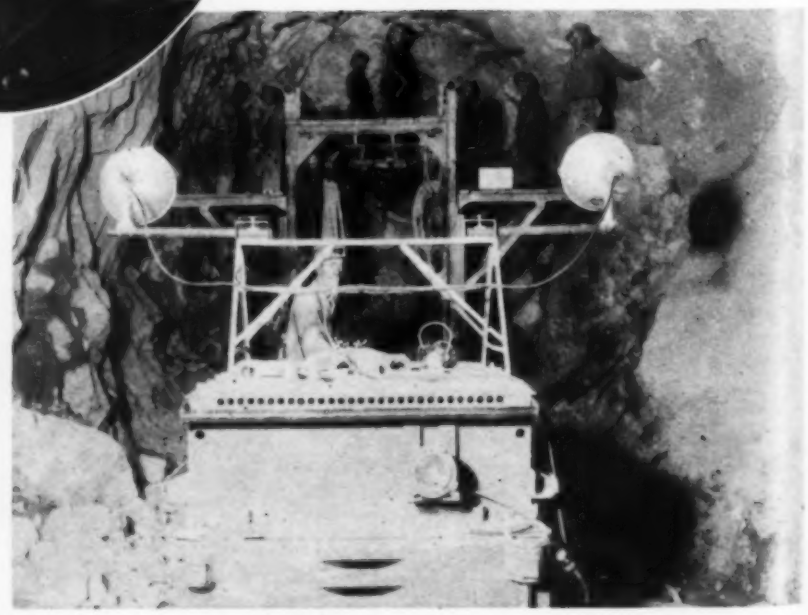
14 CONNECTING CORD *(right)* in position for blasting, showing transformer and switch (at right) and blasting switch (at left).

15 TRUCK FOR TRANSPORTING EXPLOSIVES displays sign and red flags at both ends. In background, main tunnel magazine.

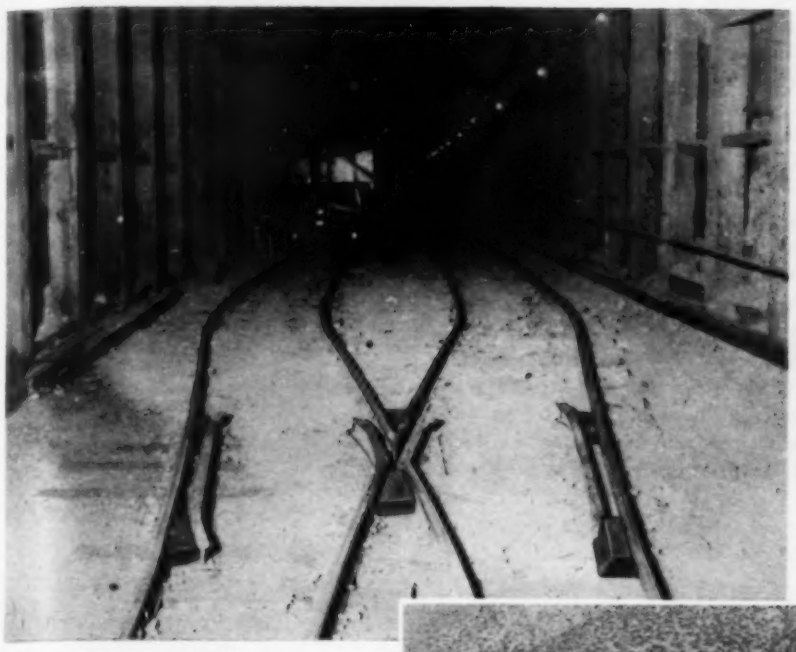
16 FROM EXPLOSIVES MAGAZINE powder is loaded into two-compartment cars for delivery to tunnel.

18 PLAQUE *(in inset, above)* is awarded as prize in first-aid contest.

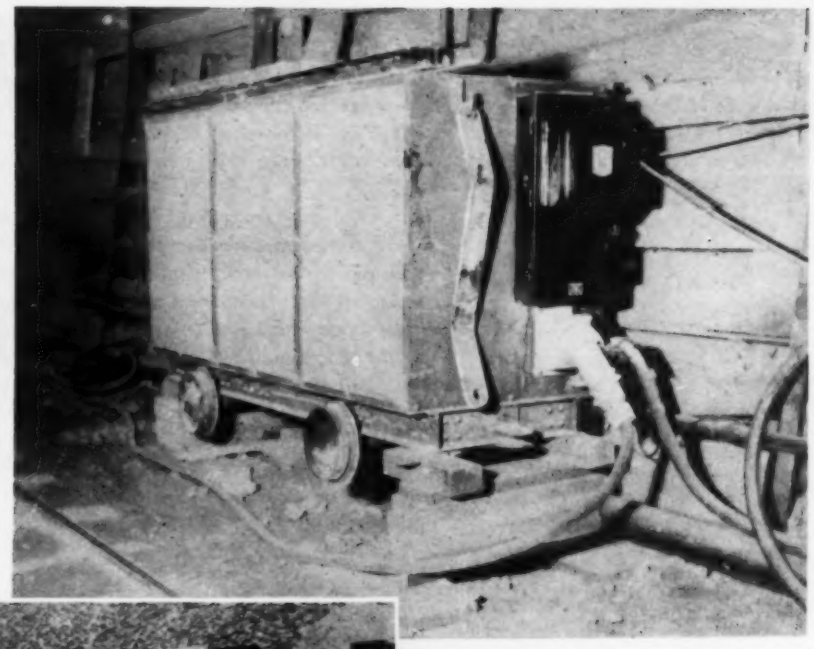
17 HARD PROTECTIVE HATS of molded micarta are required for all workmen and other persons in tunnels under construction.



19 HEADING ILLUMINATION is provided by flood-lights plugged into electric battery locomotive 100 ft. from face.



20 WOOD BLOCKING in switch frogs and guard rails prevents workmen's feet from being caught.



21 PORTABLE ELECTRIC TRANSFORMER in tunnel is of 2,300-440-volt dry type.

22 MAN CARS provide safe and comfortable transportation for tunnel workmen on trips to and from heading.

Fire-proof, bullet-proof and well ventilated magazines are provided for the separate storage of dynamite and blasting caps, and for operations incident to making primers and slitting dynamite cartridges. (Figs. 11 and 12) These magazines are located at least 100 ft. apart and at safe distances from construction operations, buildings, highways and railroads.

SAFETY PRIMERS are used exclusively in blasting at tunnel headings on District work, and to a considerable extent on contract work. (Figs. 11, 12 and 13.) During the period June 1, 1934 to March 1, 1935, more than one-half million of these primers were fired with satisfactory results as to safety and efficiency.

POWDER CARS. Dynamite and primers in suitable boxes are transported from magazines to tunnel headings in separate powder cars, or in a two-compartment powder and primer car (Figs. 10 and 16.) Electric battery or trolley locomotives are used exclusively in tunnel haulage.

ELECTRIC BLASTING is used exclusively at tunnel headings. The standard blasting equipment (alternating current) embraces the following features:

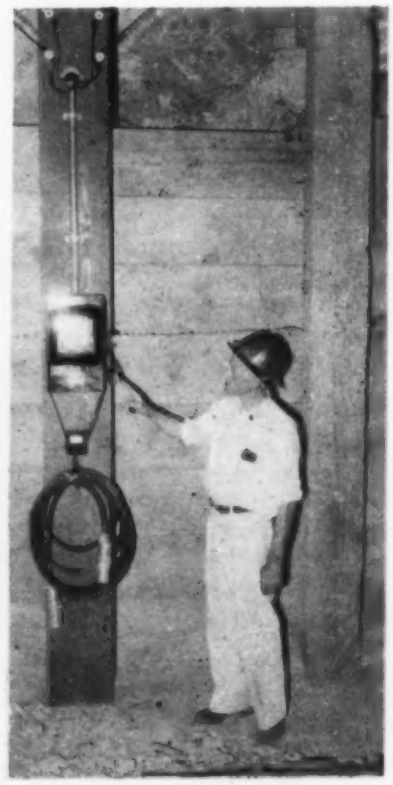
(1) *Permanent Blasting Lines*—Wiring shall not be smaller than No. 8 AWG rubber covered or weatherproof wire, installed on glass insulators or large porcelain knobs on side of tunnel opposite all other electric circuits and pipe lines. Wires shall be kept at least 5 in. apart and not less than 8 ft. above the tunnel floor, and shall be kept clear of any contacts except at points of suspension. Splices shall be staggered, soldered, and covered with rubber tape, varnished cambric and at least four layers of friction tape, or otherwise that will provide insulation equal to that of the wire.

(2) *Transformer and switch at Source of Blasting Current*—A separate 2,300-440 volt, 5-kw. minimum capacity transformer (Fig. 14) shall be provided exclusively for blasting. The voltage on the blasting circuit shall not exceed 440 v. An externally operable fused switch shall be installed to protect the blasting circuit. This switch shall not be less than 60 amp. capacity and shall be fused at not less than 35 amp. Both the transformer and switch shall be located opposite the blasting switch on the other side of the tunnel and not less than 1,500 ft., or more than 3,000 ft. from the face.

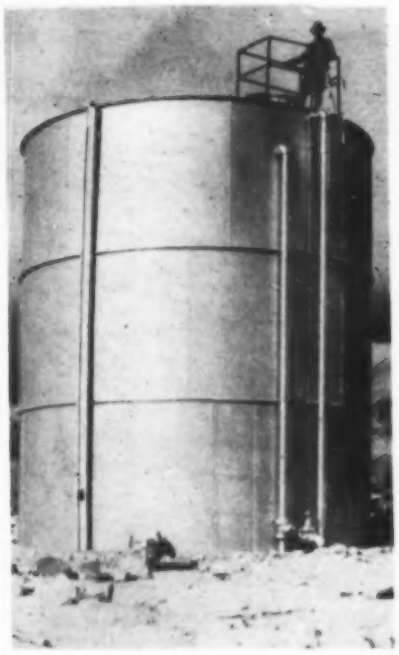
(3) *Blasting Switch*—The blasting switch (Fig. 14) shall be externally operable, double-pole, double-throw type of not less than 60-amp. capacity and shall normally be held in the "off" position by means of a suitable spring attached to the handle outside of the switch box. In the "off" position the two wires of the circuit shall be short-circuited, but not grounded. This switch shall be so arranged that it cannot remain in the "blasting" position when the handle is released, and the line clips shall be provided with arc-quenchers. This switch shall be of such construction that the cover cannot be removed when the operating handle is locked in the "off" position and shall be equipped with facilities to lock same in the "off" position only. This switch shall be located not less than 1,500 ft. and not more than 3,000 ft. from the face.

(4) *Portable Connecting Cord*—A two-conductor portable cord, type S, (Figs. 14 and 24) not smaller than No. 8 AWG and not less than 20 ft. long, shall be provided for making the connection between the blasting switch and the source of electric energy on opposite side of tunnel. The cord shall be

23 STRETCHER and first-aid supplies are provided near tunnel headings.



24 SAFETY SWITCH connecting cord is locked at this point except when used at blasting switch for firing.



25 GUARD RAIL is erected around man-hole of water tank.

switch shall be not less than 500 ft. back from the face.

(6) *Lead Wires* shall be not smaller than No. 16 AWG single-conductor rubber-covered copper wire.

(7) *Bus Wires* shall be not smaller than No. 16 gage AWG bare copper wire.

Bonding and Grounding—The track and all compressed air, ventilating and water pipes, and other similar electric conductors shall be bonded at intervals of not more than 1,000 ft. and shall be effectively grounded. Steps shall be taken to insure that the bond and ground connections are maintained.

Illumination — Tunnel illumination is normally provided by electric circuits. During loading and connecting-up a round electric circuits are removed from the heading and all electric energy is cut off at a distance of not less than 500 ft. from the face. During this period illumination in the heading is provided by flood lights (Fig. 19) plugged into an electric battery locomotive spotted approximately 100 ft. from the face.

Rules for blasting procedure and for handling explosives have been formulated but are too voluminous for inclusion in this article.

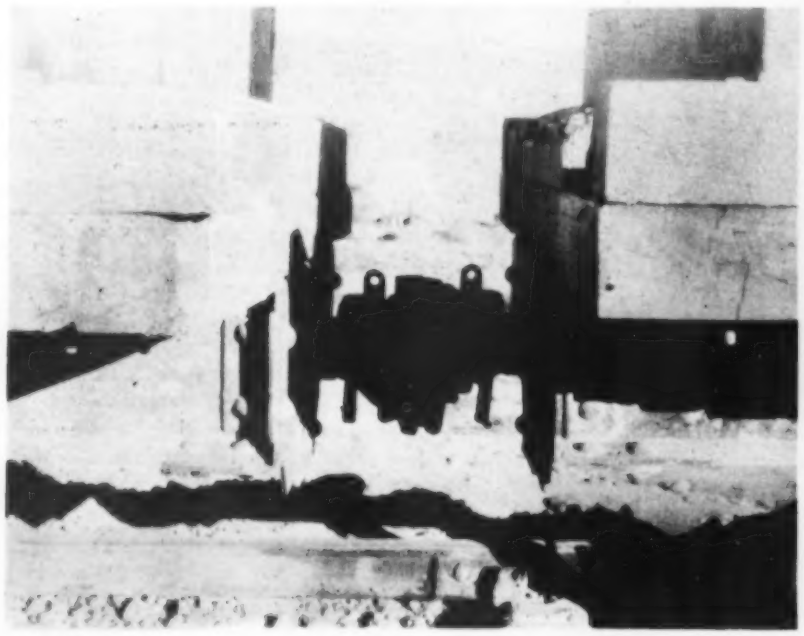
AUTOMATIC CAR COUPLERS (Fig. 27) facilitate haulage and unquestionably are superior, from the safety viewpoint, to other types of couplers.

MOVING MECHANISMS of machines are guarded to prevent personal contact and injury. (Fig. 29)

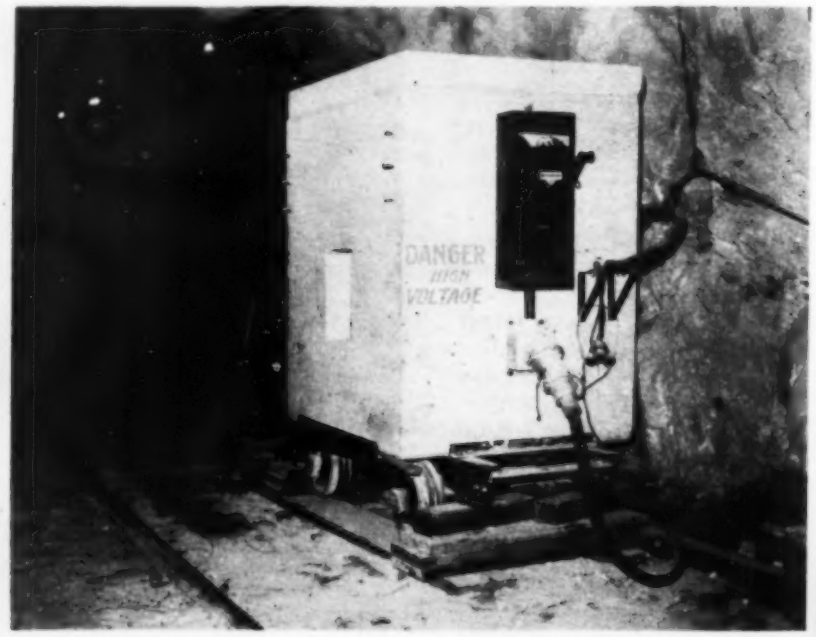
MEDICAL. First-aid supplies and stretchers (Fig. 23) are kept in suitable cabinets near the headings and at other points in the tunnels. On each shift there are two or more men who have received U. S. Bureau of Mines first-aid training. First-aid stations, in charge of trained nurses, are located near the tunnel portals. Hospitals, with a high standard staff, equipment, and facilities (Fig 1) are located at strategic points on the aqueduct.

RAILINGS. Elevated platforms and

26 GOGGLES are worn by grinding operator. Grinding wheel equipped with tool rests, guards and push-button control.



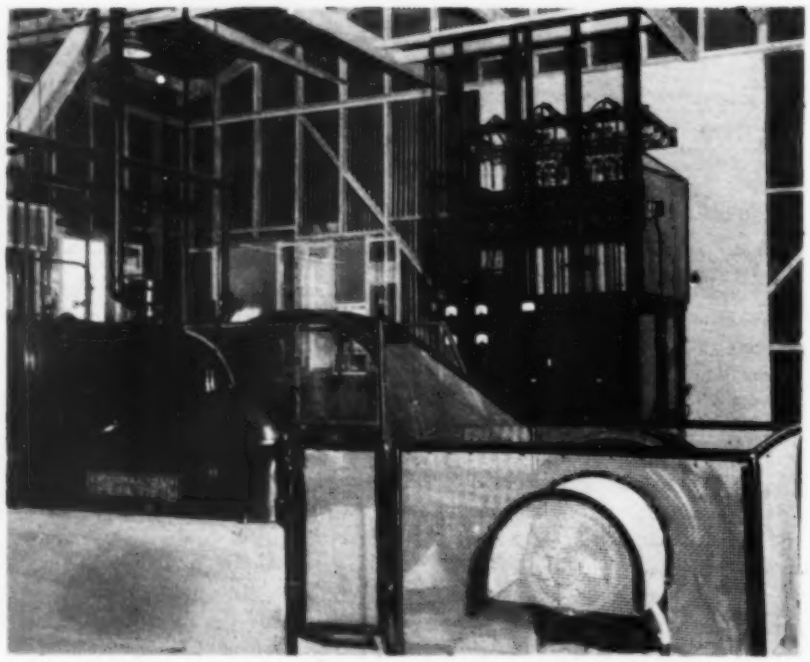
27 AUTOMATIC COUPLERS minimize accidents in handling tunnel cars on aqueduct work.



28 PORTABLE ELECTRIC TRANSFORMER of 2,300-440-volt oil type is housed in concrete vault in tunnel.

connected to power and blasting circuits by means of plugs and receptacles (Crouse-Hinds industrial or equal) of not less than 60-amp. capacity. These plugs and receptacles shall be of a type which has provision for preventing the plugs from being accidentally pulled out of the receptacles, and shall not be interchangeable with any other plugs and receptacles at any one camp.

(5) *Safety Switch* — The safety switch (Fig. 24) shall be of the same type and rating as the blasting switch but shall not be equipped with spring. In the "off" position the lines from the face of the tunnel shall be disconnected from the source of electrical energy feeding in from the blasting switch. In the "off" position, the two wires of the circuit shall be short-circuited but not grounded. The safety



29 WIRE MESH GUARDS are used to inclose air compressors and switch panels at compressor plants serving tunnels.

runways are guarded by substantial two-rail railings, 3½ ft. high. (Fig. 25)

MISCELLANEOUS. This article deals only with the more outstanding features of safety on the aqueduct. There is a multitude of other items of importance, such as hard-toe shoes, respirators, abatement of dust, ventilation, mine hoists, sanitation, change houses, fire protection, tests and analysis of tunnel air, safety rules and discipline.

Good physical conditions on the work have contributed liberally to the purpose, but experience indicates that the credit for minimizing the number of accidents on this project is due in a major degree to the development of the safety spirit within the entire organization .

Surveyors Use
ALPINE CLIMBING TECHNIQUE

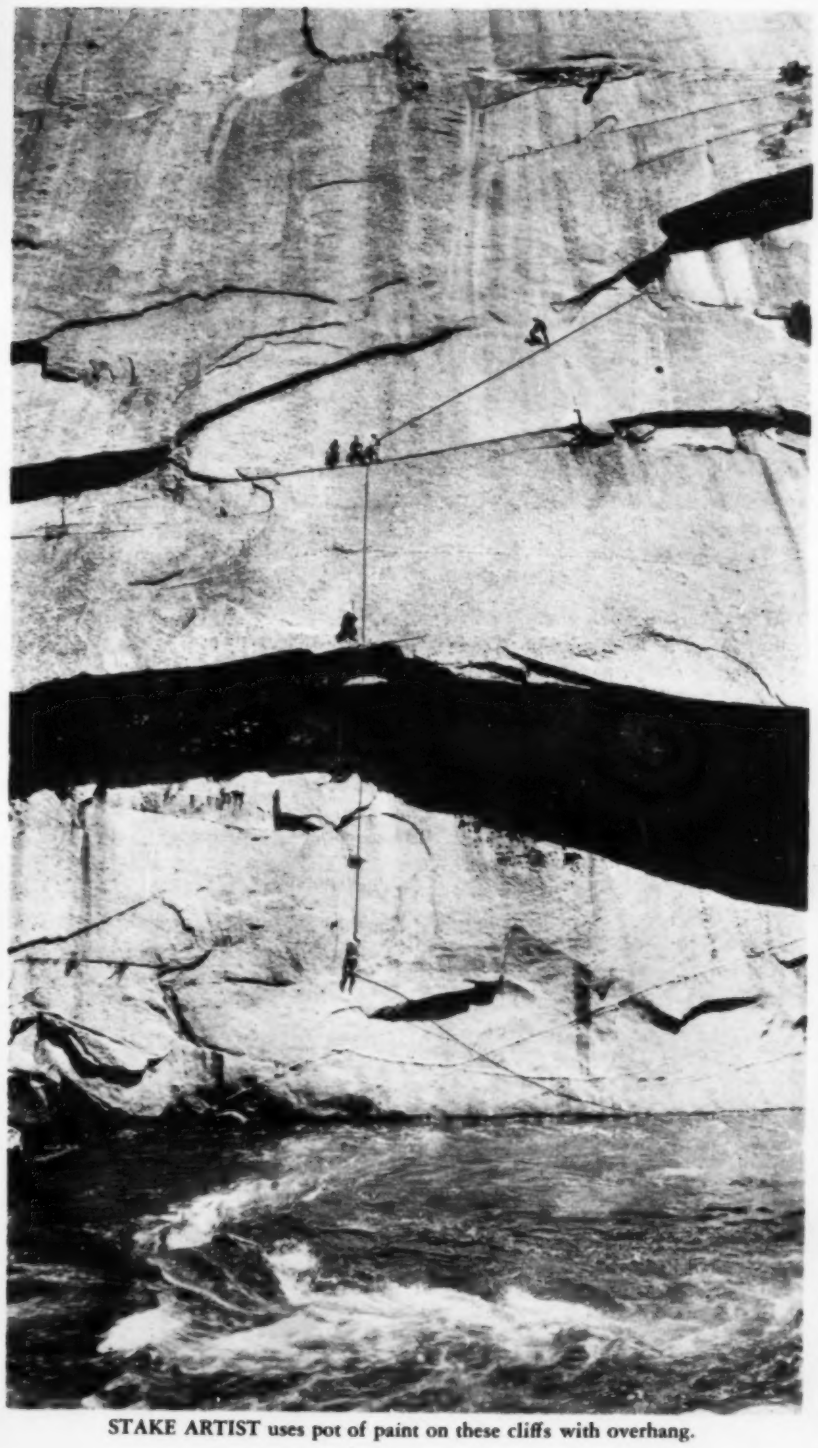
APPROACHING GRANITE CLIFFS survey lads got accustomed to setting up near edge.

MOVING UP the "gun" was all right if transitmen did not slip.

DURING the summer of 1934 the California Division of Highways ran a preliminary location survey along the south side of Feather River canyon (north fork) on such precipitous slopes that the men on the survey crew at times worked on the end of a 600-ft. rope.

Some 3 mi. of the canyon are to be transversed by the road which will be in tunnel for a short distance around Eagle Rock and Grizzly Dome, in the vicinity of which the accompanying pictures were taken. Five men worked in the survey party locating a roadbed only 40 ft. above water level—as low as was thought to be safely above the level of winter floods.

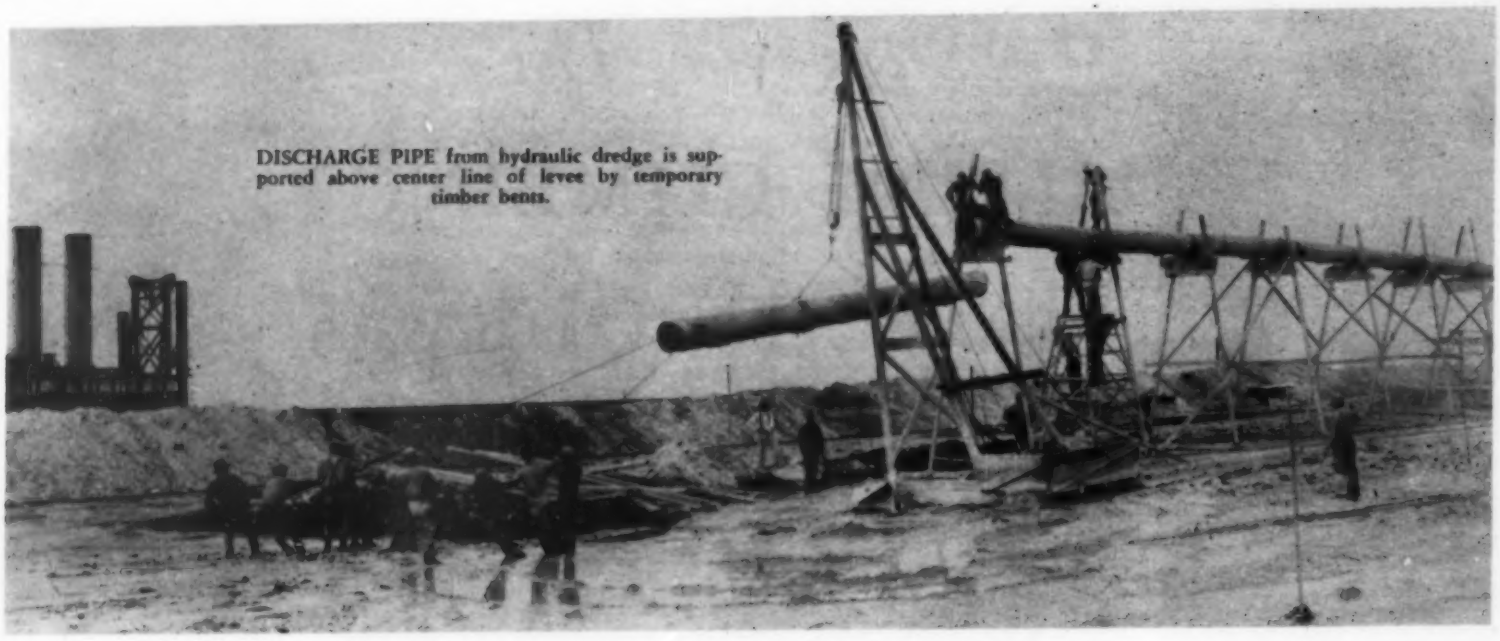
At this point the river goes through a narrow granite gorge, on one side of which the only possible location is occupied by the Western Pacific Railroad. The opposite side is a smooth granite face, part of which is known as Grizzly Dome and part as Arch Rock. These faces are characterized by the scaling off of layers similar to the layers that can be peeled from an onion. This scaling, which has been going on for centuries as the result of weather action, doubtless would be affected by cuts made for road purposes along the granite face. Accordingly, to avoid some of the most exposed locations tunnel construction is being contemplated. In making preliminary surveys on this route the surveyors have had a chance to show the stuff of which they were made. The work was done under the general direction of Fred J. Grumm, engineer of surveys and plans, California Division of Highway.



STAKE ARTIST uses pot of paint on these cliffs with overhang.

DIFFICULT SET-UP for transit in Feather River gorge.

A MISSTEP would be as good as a mile at this station.



DISCHARGE PIPE from hydraulic dredge is supported above center line of levee by temporary timber bents.

HYDRAULIC DREDGING

Builds Levees at Lake Okeechobee

HYDRAULIC DREDGING methods are being employed at considerable saving in cost over bucket-type excavators in placing much of the 50,000,000 cu.yd. of materials required to construct 66½ mi. of levee along the south shore of Lake Okeechobee, at the head of the Everglades in Florida. These methods of handling material also produce a better embankment for the conditions involved than was obtained earlier on this project with bucket machines. The results are specially significant in view of the fact that the materials encountered range from soft sea sand to thin strata varying from marl to hard limestone.

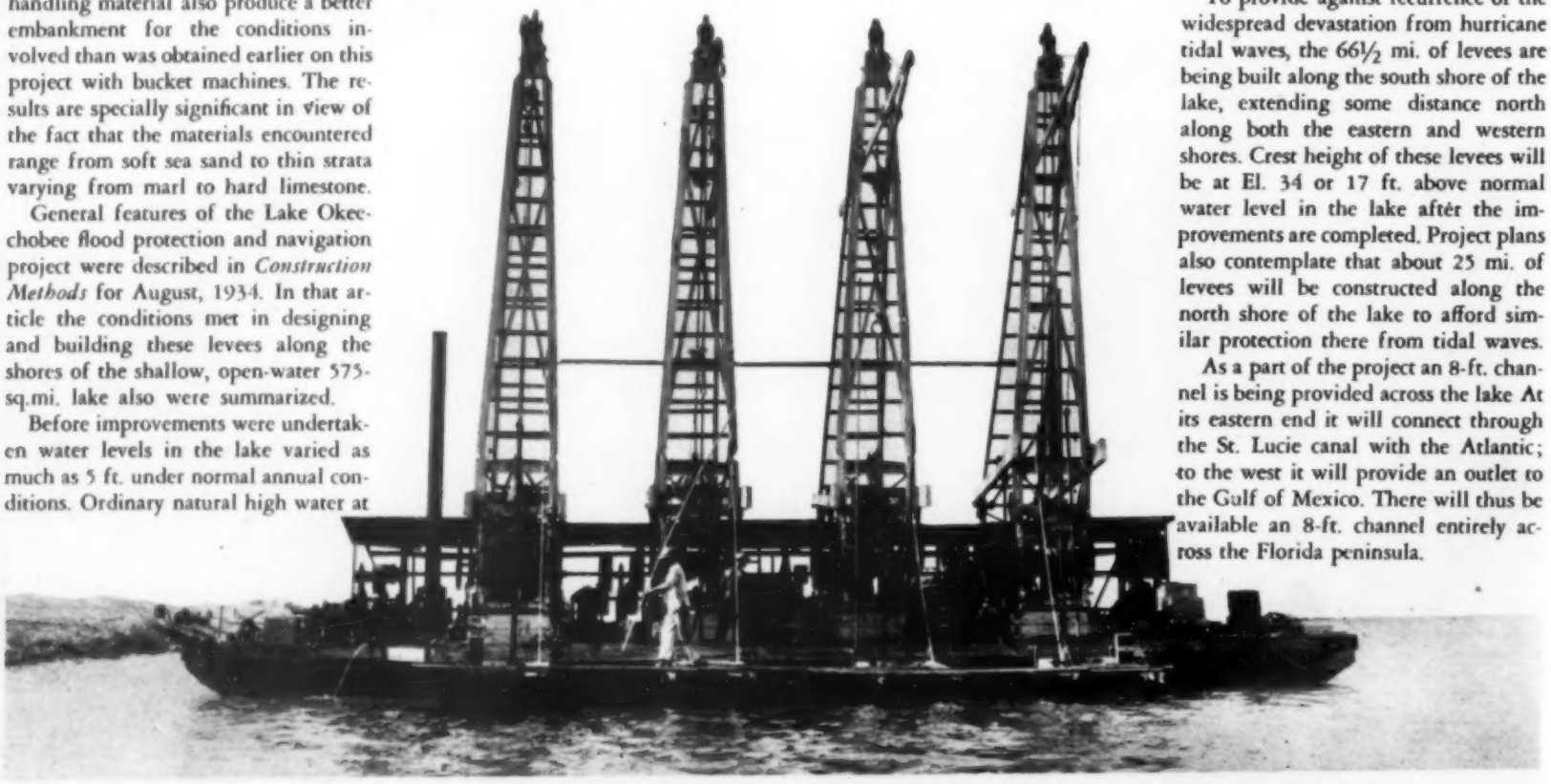
General features of the Lake Okeechobee flood protection and navigation project were described in *Construction Methods* for August, 1934. In that article the conditions met in designing and building these levees along the shores of the shallow, open-water 575-sq.mi. lake also were summarized.

Before improvements were undertaken water levels in the lake varied as much as 5 ft. under normal annual conditions. Ordinary natural high water at 21 ft. overflowed the almost flat shore line into the vast swampy Everglades extending from the lake for more than 100 mi. to the southern tip of the Florida peninsula. Bare hurricanes have forced the water of the lake into great tidal waves which swept away much of the limited improvements along the shores and caused great loss of life.

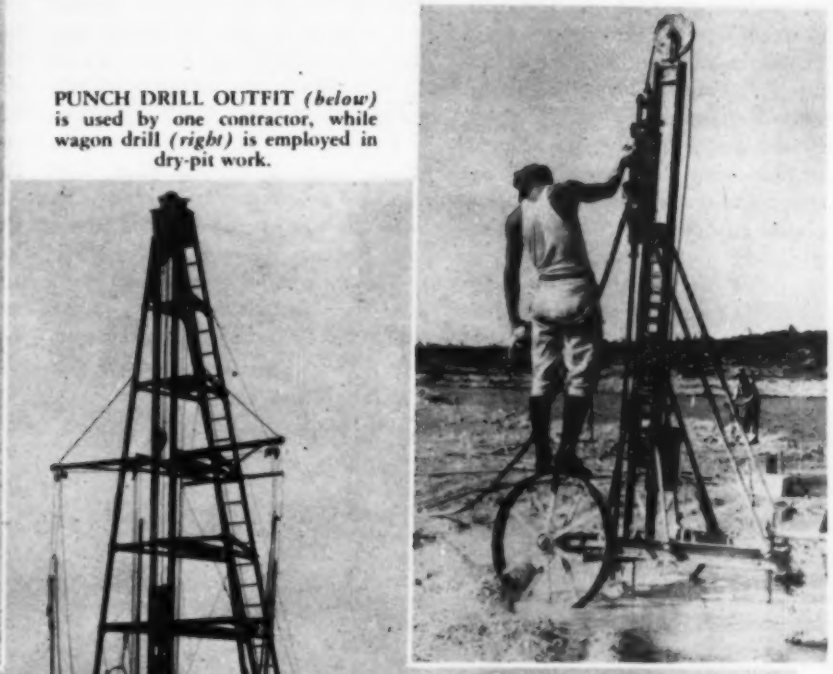
Outlet Channels—Under the present project the St. Lucie canal, leading directly east to the Atlantic Ocean, is being improved to provide a normal carrying capacity of 5,000 sec.-ft. Caloosahatchee River, extending from the west shore of the lake to the Gulf of Mexico, also is to be dredged and widened to provide an outlet in that direction with a capacity of 2,500 sec.-ft. Some dependence will be placed on the existing private canals across the Everglades to take overflows from the lake. With the various outlets thus available the expectations are that the lake level may be maintained at desired stages under normal conditions without damage to adjacent lands.

To provide against recurrence of the widespread devastation from hurricane tidal waves, the 66½ mi. of levees are being built along the south shore of the lake, extending some distance north along both the eastern and western shores. Crest height of these levees will be at El. 34 or 17 ft. above normal water level in the lake after the improvements are completed. Project plans also contemplate that about 25 mi. of levees will be constructed along the north shore of the lake to afford similar protection there from tidal waves.

As a part of the project an 8-ft. channel is being provided across the lake At its eastern end it will connect through the St. Lucie canal with the Atlantic; to the west it will provide an outlet to the Gulf of Mexico. There will thus be available an 8-ft. channel entirely across the Florida peninsula.



FLOATING DRILL BARGE is employed by one contractor to put down holes for blasting hard strata prior to removal by hydraulic dredging.



PUNCH DRILL OUTFIT *(below)* is used by one contractor, while wagon drill *(right)* is employed in dry-pit work.

COMBINATION METHOD of levee building employs hydraulic dredge and dragline. Dragline, in distance, builds retaining dikes between which lift of levee is placed hydraulically. Second dragline, in foreground, rehandles dredged material to form dikes for next lift.

Material and Water Conditions — The bed of Lake Okeechobee and the surrounding areas are still in the process of formation. Materials vary widely in short distances, with uniform deposits the exception. There usually are, however, underlying strata of marl or limestone. In many places these materials come close to the surface. In others, they are overlaid to considerable depths with sea shells, sand and material that is almost collodial. These overlying materials also generally contain strata of marl and limestone varying from a few inches to several feet in thickness. As a general rule, the surface is a layer of partly decayed growths of reeds and swamp grasses, woody growth being quite rare.

Water depths are slight along most of the levee locations; in fact, the lake itself is in no place more than 20 ft. deep. There is ample water, however, to permit operation of floating equipment. By borrowing material for the levees from the location of the minimum 8-ft. permanent channel, much greater depths than that have been available along the work.

Early Methods of Construction — Prior to the award of contracts for the first sections of the levee, the Corps of Engineers, U. S. Army, in charge of the design and execution of the project, undertook extensive studies to determine the probable behavior in embankments of the local materials. Several thousand feet of full-size levee were built as a basis for these investigations. Out of these preliminaries were evolved specifications that have since been followed with few important changes. The latter have been mainly in the elimination of the surface muck from the materials permitted in the embankment and modifications of the levee surface slopes on the lake side.

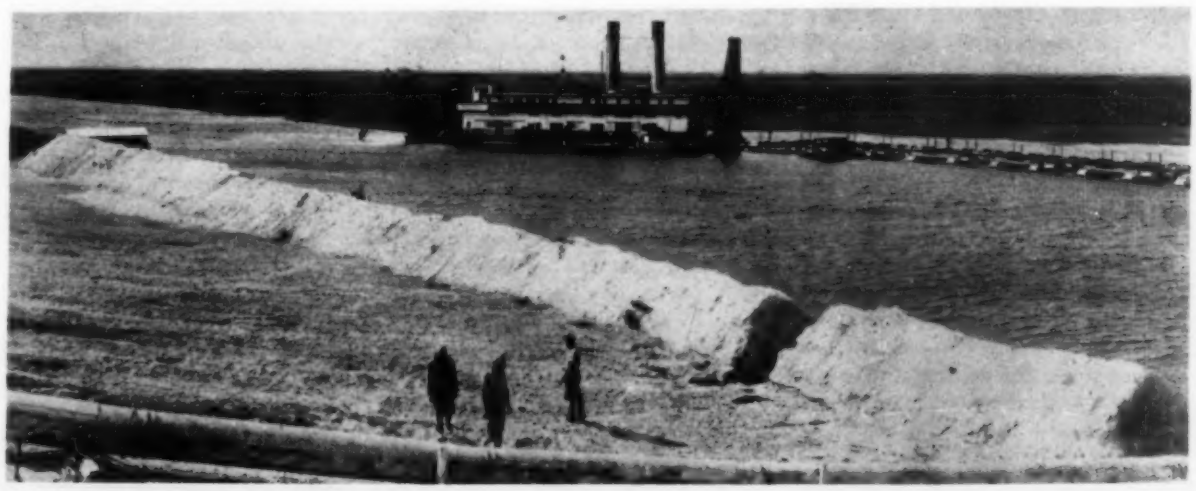
From the beginning the Corps of Engineers specified that the embankments might be built either with dragline excavators or by hydraulic dredges. The embankment sections for the two methods of placing materials varied markedly, with much flatter slopes and about 15 per cent more material in the hydraulic-dredge type.

With one exception, all of the qualified low bidders on the first 37 mi. of levee for which contracts were awarded elected to use dragline excavators. Some employed crawler-type machines, others used floating equipment while a few had a combination of the two. These contractors bid from 14.5 to 35c. per cubic yard of completed embankment, prices including the grassing of embankment slopes. Wave protection along the inshore water line was a separate item.

In the article in this journal previously referred to the methods employed on these early contracts were discussed in detail. As a general proposition, good results were obtained with the dragline machines. A section begun with hydraulic dredges by one contractor was inadequately planted, but from the results obtained with this limited equipment it became evident that hydraulic-dredge methods offered opportunities for constructing levees under the local conditions at less total expense than the cost of doing the work with dragline machines. The resulting embankment also was more stable.

Based on these conclusions, the Corps of Engineers elected to take over a section of levee on which the contractor was badly behind schedule, in order to give the hydraulic-dredge method a thorough trial. The Army Engineer Department 20-in. dredge "Welatka" was brought to the site and operated as described in the previous article. Out of the experience with this dredge it was evident that exceptional power was required on the dredge cutter shaft. Cutters specially designed for the local conditions also were found necessary. Angles and depths at which the cutter worked had a great effect on the amount of materials delivered.

There were various other similar fundamental conditions determined. But the advantage of a properly equipped and properly powered hydraulic dredge over any kind of a dragline machine on this particular work was evident.



HYDRAULIC DREDGE "GENERAL" delivers material from borrow in channel to place in the levee along south shore of Lake Okeechobee.

Among the hydraulic-dredge advocates, however, there was still serious doubt that this method could be used successfully in sections where considerable rock was encountered.

Hydraulic-Dredge Methods—Opportunity to give the hydraulic dredge method a trial under the most difficult material conditions on the project occurred when a contractor using draglines failed after placing a considerable part of the base of a section of levee. The Corps of Engineers then leased from the Arundel Corp. the 24-in. heavy-duty dredge "General" to deliver material to the levee from the borrow area adjacent to the offshore toe for about 9c. per cubic yard. This dredge is modernly equipped with ample power and has a heavy cutter ladder and cutter shaft. She has 500-hp. on the cutter and 1,800 hp. on her pump, the cutter having a 25-per cent overload capacity for short periods. This dredge placed 1,060,000 cu.yd. of net material in the levee in one 90-day period. Her best month was approximately 390,000 cu.yd. On these particular sections loss of material from the borrow pit measurements to the pay quantities in the embankment averaged 20 per cent.

Normal plans of operation where the hydraulic dredge places the entire levee are, first, to throw up low retaining dikes along both toes of the final slopes with small dragline machines. These dikes usually are kept at least ½ mi. ahead of the point where the dredge is discharging; they are built high enough to retain the main fill to its entire height on the final slopes.

Regular hydraulic dredge procedure also calls for the discharge pipe to be erected on temporary bents along the axis of the embankment. With stop-boards it is easy for an experienced crew to direct the material almost exactly to the determined slopes of the levee.

In some localities the percentage of collodial material presents a problem. Moving ahead in considerable amounts it settles to form the base of the levee. Drainage of the layer of fine material thus built up is slow. Erosion of this material when exposed in the face of the embankment where wave action may reach it is very fast. These conditions have been of only occasional occurrence. In most instances the bulk of the finer materials settles rather promptly after being discharged, the collodial matter being carried away in the waste water. Where the hydraulic dredge is placing the entire embankment the practice has been to locate a temporary wooden spillway outlet in the low retaining dike along the offshore toe of the levee. It is placed so as to produce the maximum possible settlement of desirable materials between the retaining dikes.

These more or less general standard methods have been followed in operating the dredge "Welatka" and the Army Engineer Department dredge "Gulfport," which are both in service on the project. In the case of the dredge "General" the discharge pipe is placed slightly inshore from the axis of the levee in order to place the materials as nearly as possible in final location. Because the base of the embankment being finished by this dredge had been thrown up with draglines some rehandling of the material delivered by the dredge is necessary to obtain the final slopes. Draglines do the bulk of this rehandling, with blade grader machines drawn by tractors doing the fine finishing. Even with this combination dredge and dragline operation, the final cost of material in place, including grassed slope protection, does not exceed 14c per cu.yd.

On 5.5 mi. of levee undertaken under contract the Arundel Corp. started operations with large land dragline machines as the main units of its plant, supplemented with smaller draglines for various auxiliary operations. Later this contractor developed a combination dragline and hydraulic dredge method of placing the embankment. Using this combination, low retaining dikes were thrown up ahead in the usual manner. Then the dredge filled to the top of these dikes without the use of stop boards, so the surface of the hydraulic fill was about flat. Next, the large dragline rehandled part of the hydraulically-placed material to bring the retaining dikes up for another lift placed by the dredge. In this sequence the embankment was carried to the proper height, and with standard dragline section slopes.

Based on the earlier experiences with the "Welatka," the original ladder on this dredge was replaced with one that was much heavier. Her original 60-hp. engine for handling the ladder and swinging wires was replaced with a 140-hp. motor. A 250-hp. steam engine on her cutter also was replaced with a 490-hp. motor with ability to handle 10-per cent overload for some time.

Thus re-equipped, the "Welatka" has shown the value of ample power for the heavy rock excavation, although at the time these notes were prepared she had been in service less than 30 days. During that short period after she was broken in she handled as high as 12,000 cu.yd. of material delivered in place in the embankment in 24 hr.

Types of Cutter—Basket and open-blade cutters have been used on the three large dredges on this project. The basket type is suitable only for soft materials. On account of the very heavy service in hard material and rock, modifications of the usual open-blade type of cutter have been found desirable. Accompanying views show the spacing and length of blades of these cutters; attention is called to the use of wire cable threaded between the cutter blades to keep from entering the suction larger pieces of rock than will readily pass through the pump and the discharge line.

Due to the constant variation in the materials as they occur in the borrow pit, no fixed method of dredge operation is practicable. This variation also affects seriously the amount of material delivered from time to time by the dredge. As previously mentioned, the angle of the dredge ladder and the slope of the blades on the cutter determine importantly the output in different materials and at varying depths. When handling broken rock the output of fine material will run low. There is, therefore, no way to estimate in advance the probable day-to-day output of a dredge on the project. There appear to be possibilities of increasing capacity considerably by using a dredge equipped with a ladder having one angle and a cutter with one pitch of blades to a certain depth, and another dredge following to finish the excavation with another angle on its ladder and a different cutter pitch, but this has never been tried.

Handling Hard Materials—Handling of the thin strata of hard materials ranging from marl to hard limestone is one of the outstanding features of the hydraulic-dredge operations. In all cases where the contractors have placed the embankments with dragline machines these strata have been drilled on 8-ft. centers in both directions. When excavating under water floating drill boats have been employed. Where the dry-pit method of excavating was used, holes were made with portable land drills. Loading has been with from 4 to 6 lb. of 60-per cent dynamite to the hole. On account of the thinness of the hard strata, varying results have been obtained in blasting. There has been some question as to whether blasting has in all cases been effective enough to justify it.

GRASS *(above)* is planted on slopes of finished levee section.

LOOSE ROCK *(left)* is deposited from barge as revetment along toe of dragline section of levee.

Blasting in connection with the hydraulic-dredge operations has followed about the same procedure as in dragline work. The three large hydraulic dredges have handled the broken rock with surprising effectiveness. In fact, this has been an outstanding feature of the operation of these dredges on the project. Local opinion on the project inclines to the possibility of eliminating blasting of the hard strata by using the dredges to undermine the latter so the rock and marl will drop below the minimum channel depths, or be broken by the cutters to such extent that the bulk of them may be removed by the dredges.

Experience with Retaining Dikes—One problem in building the embankments entirely with hydraulic dredges has been the lateral movement of the low retaining dikes along the inshore and offshore toes of the slopes. These dikes for some distance are on the muck that forms much of the bed of the lake. This muck compresses up to 35 per cent under the maximum depth of levee embankment. It is fairly watertight when forming the side of a pit, but under some conditions it moves easily on the underlying materials.

As a general proposition, hydraulic fills bring comparatively little thrust against these retaining dikes. When they do, side slips occur over limited areas that cause some loss of material delivered by the dredges. Volumes of pumped material thus lost average much less than the yardages that had to be rehandled due to slips on much of the work done with draglines.

Protection Against Wave Action—Protection against wave action on the lake side of the levees is also a problem that is still being studied. This is not so serious on most of the levee placed with hydraulic dredges, but is very important on the dragline sections. Protection from tidal waves and rainfall appear to be taken care of with heavy grass growths on the slopes.

Trials were made of flat plain-concrete slabs extending from about 1 ft. below normal low water to 4 ft. above that level, which is well above any lake stages except during hurricanes. As the lake will occasionally fall or be drawn below the normal low water, the slabs would be exposed to undermining. To build them deeper than 1 ft. below normal low water would entail too large an outlay. Hence, this type of protection was abandoned.

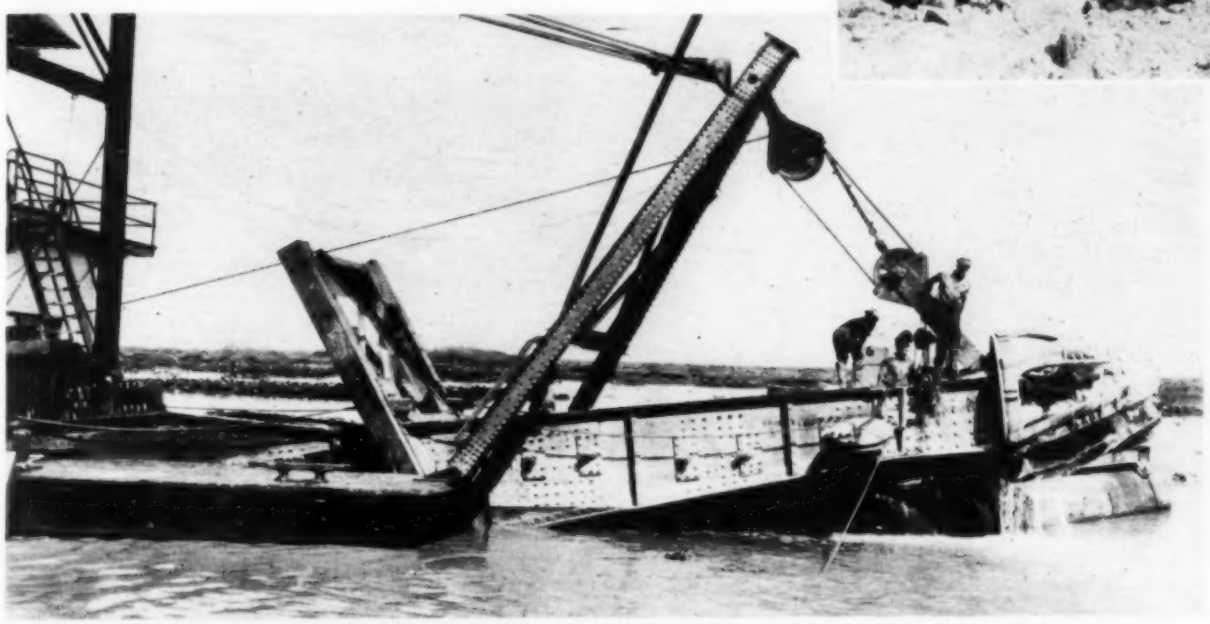
Rock riprap, 2 ft. thick and extending from 2 ft. below to 4½ ft. above normal low water, has been placed along the offshore toe of about 18 mi. of the dragline-section levees. This rock ranges from one-man to 1,000-lb. pieces.

Riprap protection is satisfactory, as erosion of material below it merely causes settlement of the rock to a new bed. Cost of this type of protection under local conditions, however, is relatively high. Other types of toe protection, accordingly, have been studied. An experiment has been undertaken to determine whether one of the heavily-rooted coarse reed grasses of the locality will grow profusely enough when protected during its early stages to provide permanent embankment toe protection. Temporary bulkheads of waste lumber were built along the toe of a levee slope for several hundred feet at nominal cost as an experimental protection. Stools of grass have been planted along the water line behind these bulkheads. The expectation is that enough growth will occur before the bulkheads decay or are washed out, barring a hurricane tidal wave meantime, to protect the toe against wave action.

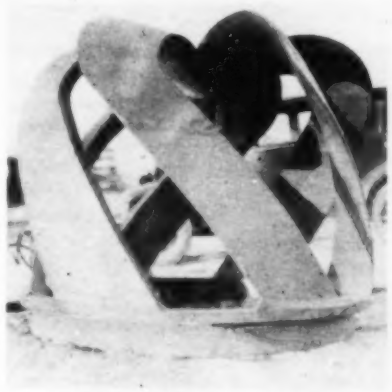
Consideration also has been given to the use of beaches of shell pumped on the flat lakeside slopes of the hydraulic-fill embankments where the type of material renders them liable to wash.

Personnel—Plans for the Lake Okeechobee flood control works were prepared by the Corps of Engineers, U. S. Army, and are being executed under the direct supervision of that organization. Major-General Edward M. Markham is Chief of Engineers, and Lt.-Col. B. C. Dunn is engineer of the district in which the project is located, with headquarters at Jacksonville. Lieut. P. A. Feringa is military assistant in that office. Carawan Nelson is engineer in general charge of the project, with Raymond C. Baird, C. C. Schrontz and Perry M. Teeple as associate engineers. Lieut. R. Selee, is resident engineer on the project, having associated with him Lieut. W. H. Mills and E. W. Digges as engineer.

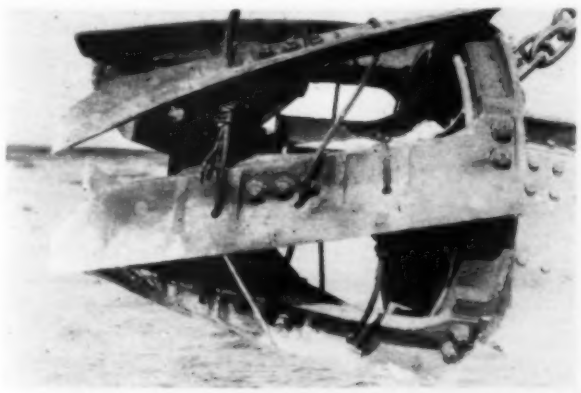
DRAGLINE handles loose rock typical of most sections of the project, including those built with dredges.

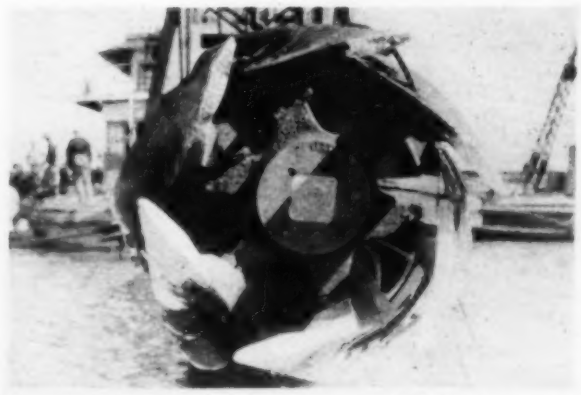


NEW CUTTER HEAD of open blade type, on heavier ladder, is installed on dredge "Welatka."



BASKET TYPE CUTTER on dredge has limited use, due to presence of hard marl and rock.

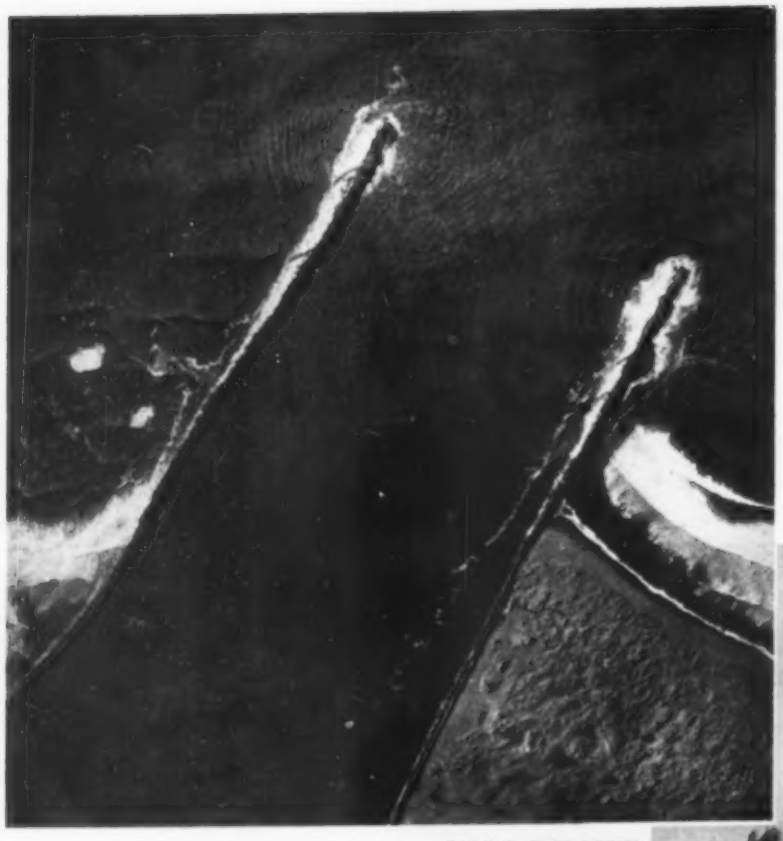




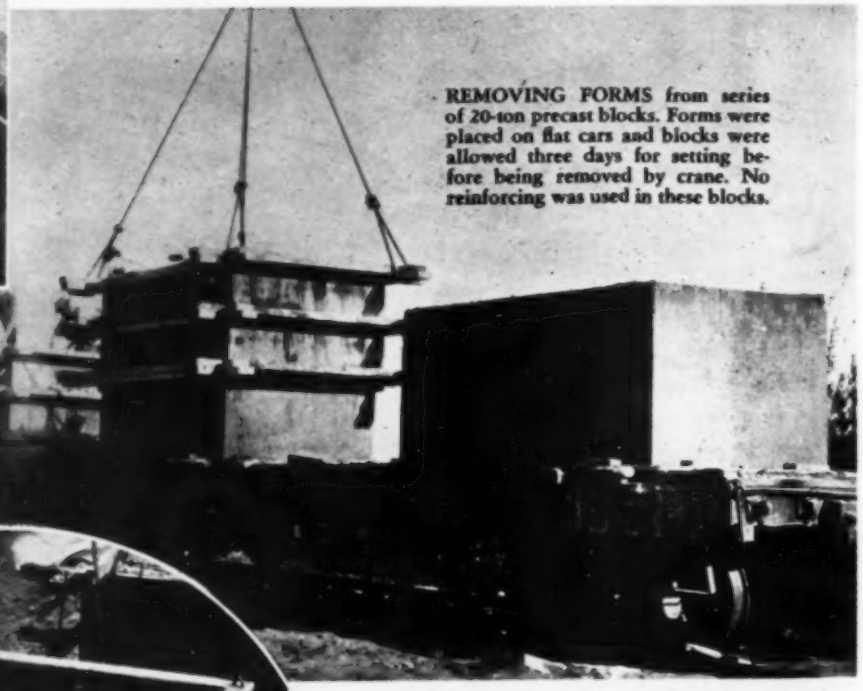
OPEN BLADE TYPE OF DREDGE CUTTER is found satisfactory for loosening layers of hard material. Side view *(left)* and end view *(right)* show wire cable wound through blades to prevent passage of oversize pieces of rock and hard marl through cutter head.

PRECAST

Balk Heavy Seas at



BIRD'S-EYE VIEW of two Humboldt Bay jetties, 2,000 ft. apart, taken in very calm weather. Casting yards for concrete blocks were located at inshore end.



REMOVING FORMS from series of 20-ton precast blocks. Forms were placed on flat cars aad blocks were allowed three days for setting before being removed by crane. No reinforcing was used in these blocks.

"CONTAINERS" *(left)* consisting of 20-ton precast concrete shells which were placed by crane and afterward filled with additional 30 tons of concrete, thus making 50-ton blocks.

AFTER 46 YEARS of construction and reconstruction work on jetties at the entrance to Humboldt Bay, Calif. (about 200 mi. north of San Francisco) a form of heavy concrete construction has been developed which is believed by the U. S. Engineer Department to be superior to any design that it would be feasible to carry out with large stone. The outstanding conclusion in the observations extending over this long construction period is that any units of construction weighing less than 20 tons are not heavy enough to retain their position under the heavy pounding which upper portions of the jetties have to take in bad storms. The total cost of the two jetties is very close to $8,000,000 but of this only about $300,000 was spent on the concrete work done in the last 4 or 5 years which is the first really stable construction that has been done above low water level on the outer ends of the jetties.

The work that was begun in 1889 consisted of the placement of about 1,150,000 tons of dumped stone, costing about $2,000,000 and covering a construction period of about 10 years. Very little work was then done on the jetties for the next 10 or 11 years but in the period of 1911 to 1927, working intermittently, about $5,600,000 was spent which involved, in large measure, reconstruction of the jetties and included placement of a concrete deck on each jetty.

When this reconstruction was undertaken it was realized that the original maximum size of 10 tons for the individual pieces of armor stone was too small and the reconstruction program increased the limit to 20 tons. Even then, however, much of the stone was in smaller pieces, practically all of which was later lost or rendered ineffective.

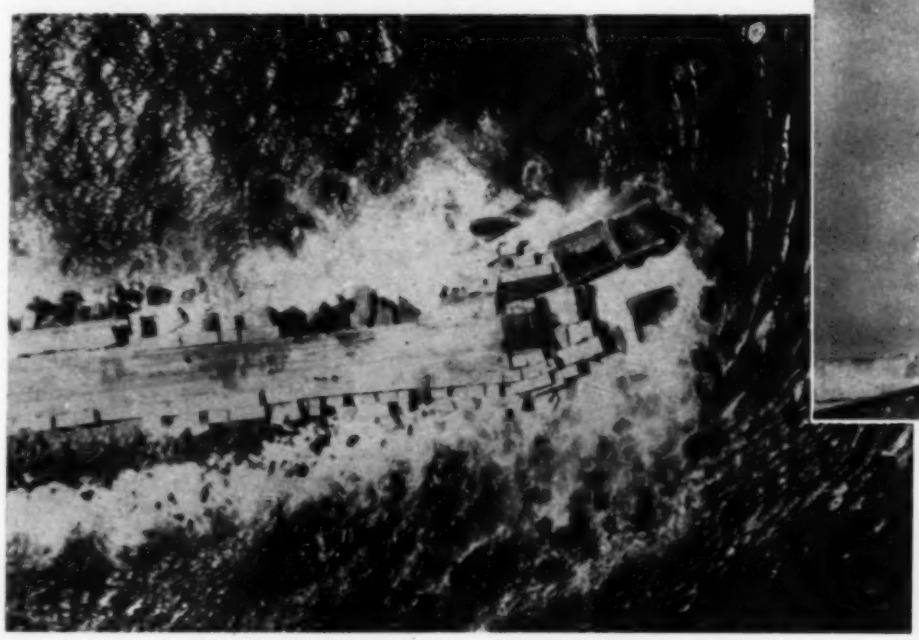
Largely because of these units of smaller size extensive work again was necessary, and about 5 years ago work

FINISHED PORTION of the jetty *(left)* showing central monolithic construction flanked by line of 20-ton precast blocks.

BLOCKS

Humboldt Bay Jetties

CRANE which placed precast blocks had capacity of 20 tons at 50-ft. radius.



CLOSER VIEW of south jetty head *(left)* undergoing rehabilitation. Note central monolithic concrete construction flanked by 20-ton precast blocks which were used as forms around space in which monolithic concrete was cast.

was begun on a complete armor of concrete above water level. For the most part this consisted of huge monoliths cast along the center of the jetties within forms built up of 20-ton precast concrete blocks which were used extensively as armor along the sides of the central monolithic portion. In this reconstruction no stone was used and the minimum size of the concrete blocks employed was 20 tons. Curiously enough experiments made with four 50-ton concrete blocks did not give satisfactory results.

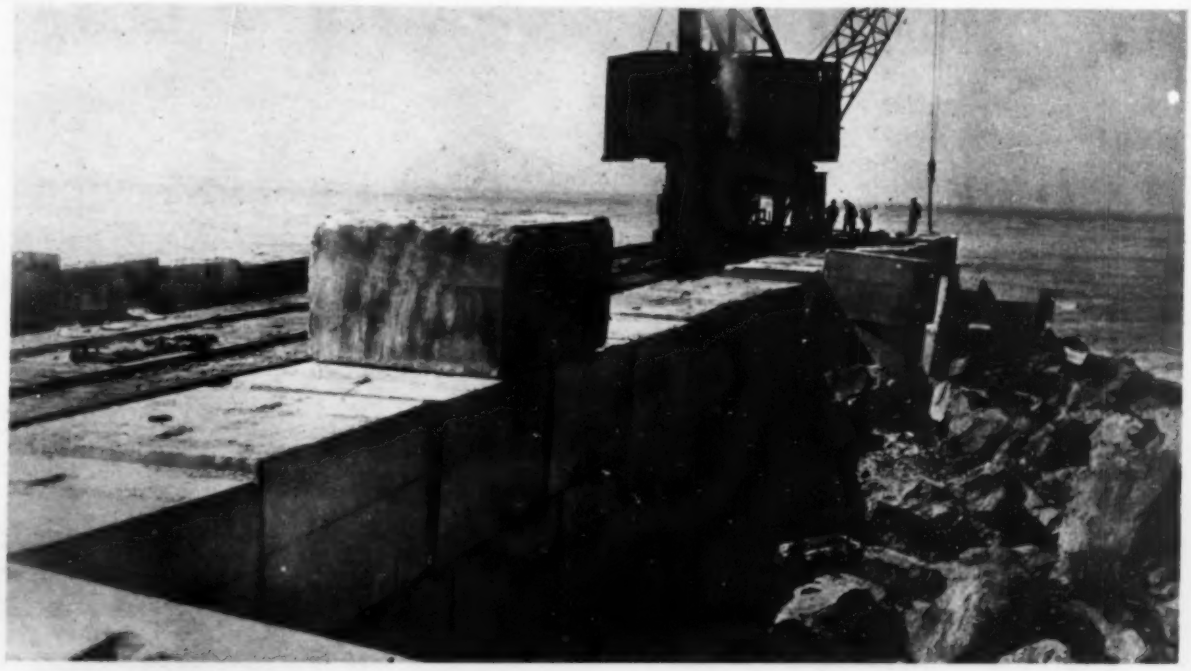
Concreting operations included about 34,000 tons of concrete at a cost of about $8.70 per ton which includes, roughly, the following items:

Track repairs	$1.18
Repairs to water system and buildings	.12
Repairs to rolling stock	.90½
Concrete	5.64
Forms	.13
Transportation	.20
Placing	.53
	$8.70½

Concrete was mixed in yards near the inshore end of each jetty. Armor along the sides of the jetty (above water line) was made of the 20-ton blocks as were the forms for the huge central monoliths cast in place.

The monoliths were formed with bottom elevation slightly above low tide and ordinarily were about 30 ft. square and 13 ft. deep. The precast blocks were used to build up the side forms for these monoliths and the side forms were left in place while those blocks used along the sea end were moved forward to make the end forms for successive monoliths. The end forms were removed after concrete in the monolith had set for one day—3 to 4 lb. of calcium chloride per sack of cement was used to accelerate setting where concrete surfaces were subject to wave wash soon after pouring.

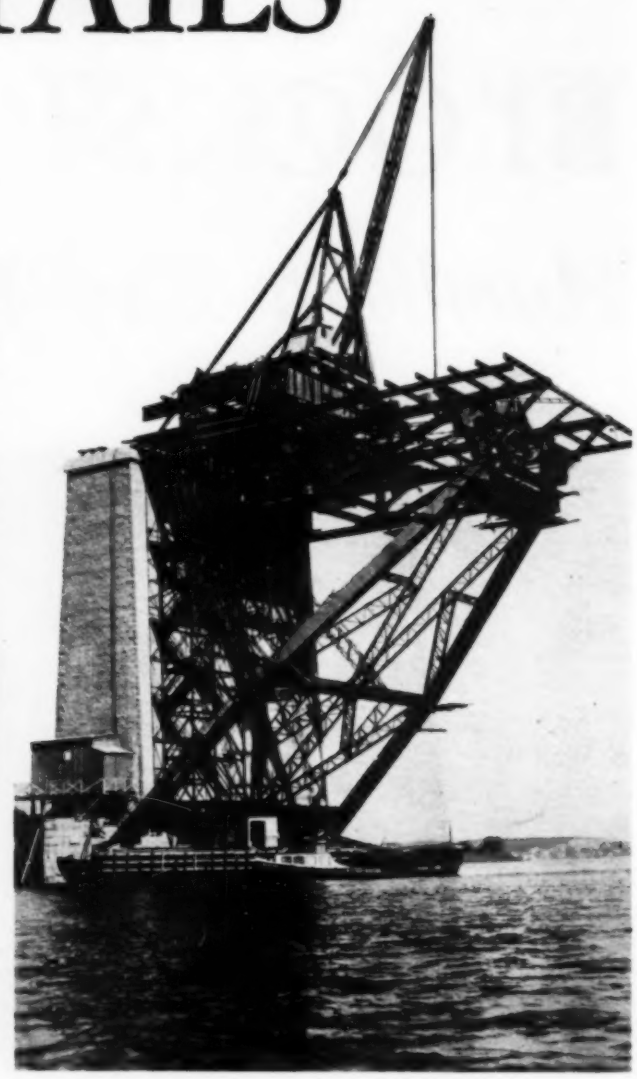
No reinforcement was used in any of the concrete. The preferred mix was 1:2:4 with a mixing time of 3 min. for each batch. Plumbs of "one-man stone" were used in the monoliths. The water cement ratio recommended was about 6 to 7 gal. of water per sack of cement.



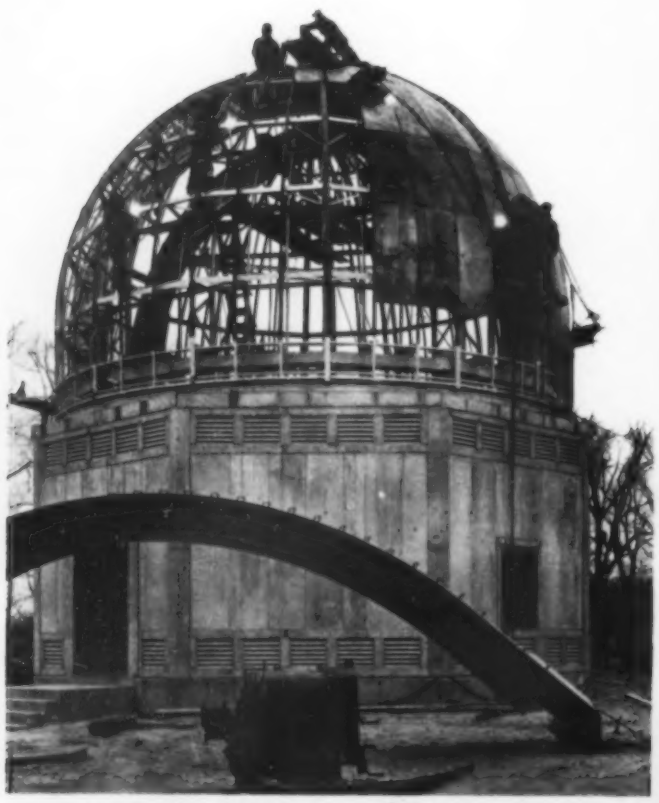
TYPICAL CONSTRUCTION near jetty head. Note that precast 20-ton blocks used as side forms for successive sections of central monoliths were left in place while blocks used at outer end of each monolithic section were moved ahead for each successive pour.

Getting Down to DETAILS

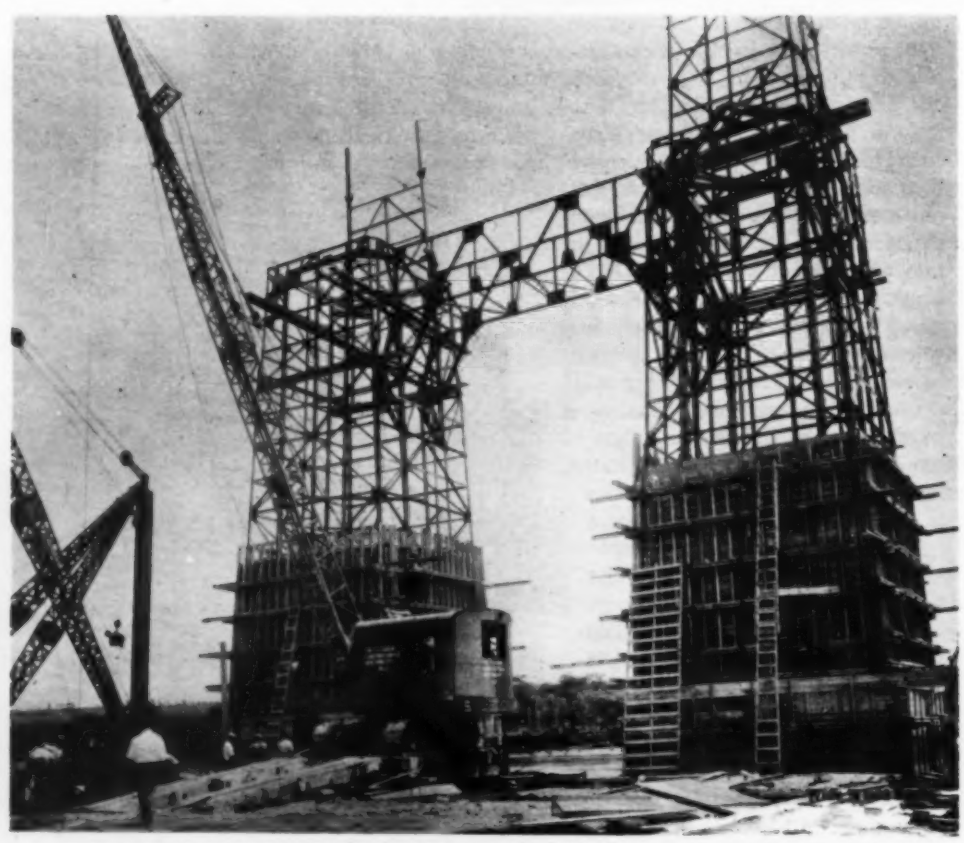
[Close-up Shots of Job Methods and Equipment]



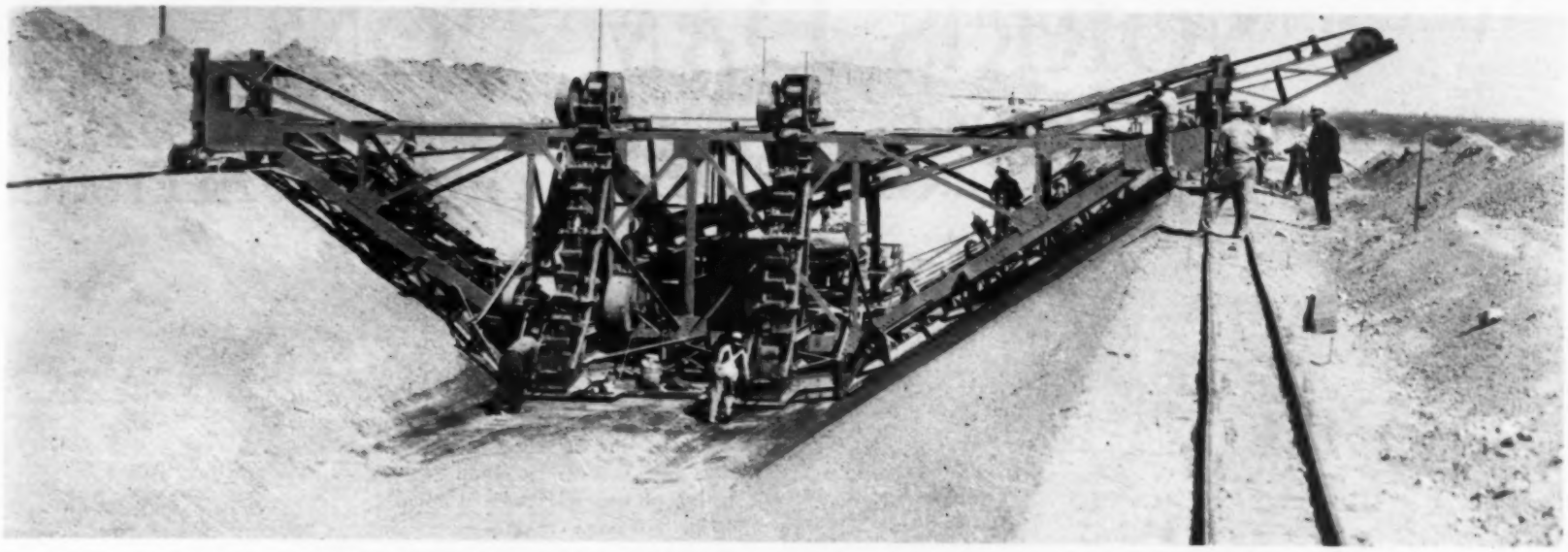
ERECTION BRACKETS *(right)* **eliminate falsework in construction of 5-span, 13,000-ton steel cantilever bridge, 2,708 ft. long, built for Danish State Railways across the Little Belt, the channel separating Denmark from the Island of Funen. Bridge superstructure is supported by four channel piers founded on caissons of unusual type, floated, capsized and sunk in water from 65 to 130 ft. deep. Brackets are built on one side of each pier to carry first few panels of steelwork which is then cantilevered outward from pier in both directions, with balanced loads, until span is connected at center. SPECIAL WORKING PLATFORM** *(above)* **of light truss construction is cantilevered out one panel ahead of main trusses to facilitate steel erection by main 25-ton traveling derrick and 10-ton auxiliary derrick. Contractors for superstructure are Fried. Krupp, A. G., Friedrich-Alfred-Hutte, Rheinhausen and Louis Eilers, of Hanover, Germany, and for the substructure Gruen & Bilfinger, A. G., of Mannheim, Germany, and Monberg & Thorsen, of Copenhagen, Denmark.**



ALL-WELDED DOME for Navy Department observatory to house 40-in. telescope, Washington, D. C., is erected by J. K. Welding Co., Inc., of New York City, under subcontract with McHarg Co., Inc., of same city, general contractor, using Lincoln equipment. Building is 35 ft. high and 33 ft. in diameter; dome revolves on turntable. Building exterior is covered with steel sheets arc-welded in place.



REINFORCEMENT OF STRUCTURAL STEEL SHAPES, instead of ordinary round or square bars, strengthens concrete shafts of pier for highway bridge crossing Cape Cod canal at Bourne, Mass. Design by Samuel Kent, chief engineer for P. J. Carlin Construction Co., of New York, permits reinforcement to be set with minimum difficulty and also offers substantial support for hanging and adjusting forms. Pier shaft concrete is delivered in buckets by crawler crane with 95-ft. boom.

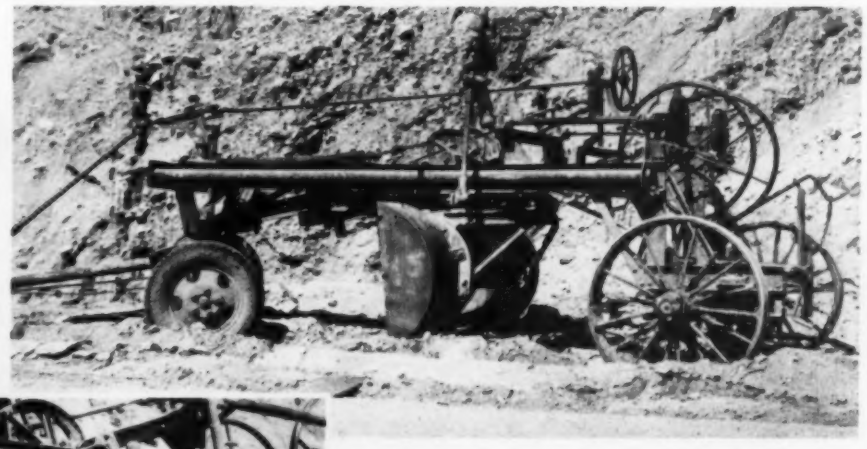


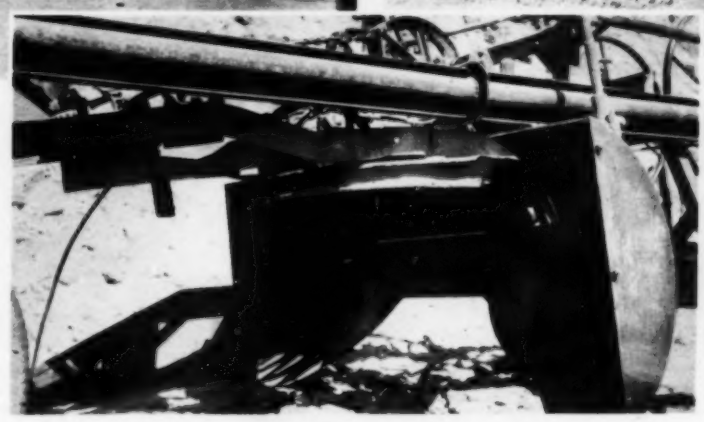
CANAL TRIMMING MACHINE is operated by Jahn & Bressi Construction Co. to bring open-cut section of Colorado River aqueduct, California, to accurate cross-section prior to lining with concrete. Power from 75-hp. gas engine operates two bucket elevators and belt conveyor; machine is moved by 60-hp. tractor. Adjustable scraper blades on sides and bottom, regulated by hand control, deliver surplus earth to belt conveyor discharging along top of bank.

PERMEABLE GROINS of precast concrete members protect from wave action and build up by accretion of sand the shore line of Lake Michigan at Sheridan Park, Cudahy, Wis. Free and extensive flow of water through openings in groin, developed by Sidney M. Wood, of Lake Bluff, Ill., deposits material evenly on both, instead of only one, side of structure. Precast concrete segments forming groin weigh from 2,500 to 6,000 lb. each and are tied together by steel rods extending vertically from sill blocks.

ELEVATED TANK IN WATER LINE equalizes pressure under heavy withdrawals by mixer and by hose cleaning steel under freshly placed deck concrete on New Jersey's $20,000,000 highway viaduct. Gasoline cart on truck (in foreground) refuels mixers and concrete trucks. Fredburn Construction Corp., of New York City, general contractor for deck.

SAFETY STRIPS *(above)* of Armco ingot iron, galvanized and corrugated, are installed along lower half of pipe guard-rail on Banner St. bridge, Topeka, Kan., to prevent children climbing or slipping through between lower rails and falling to railway tracks below.

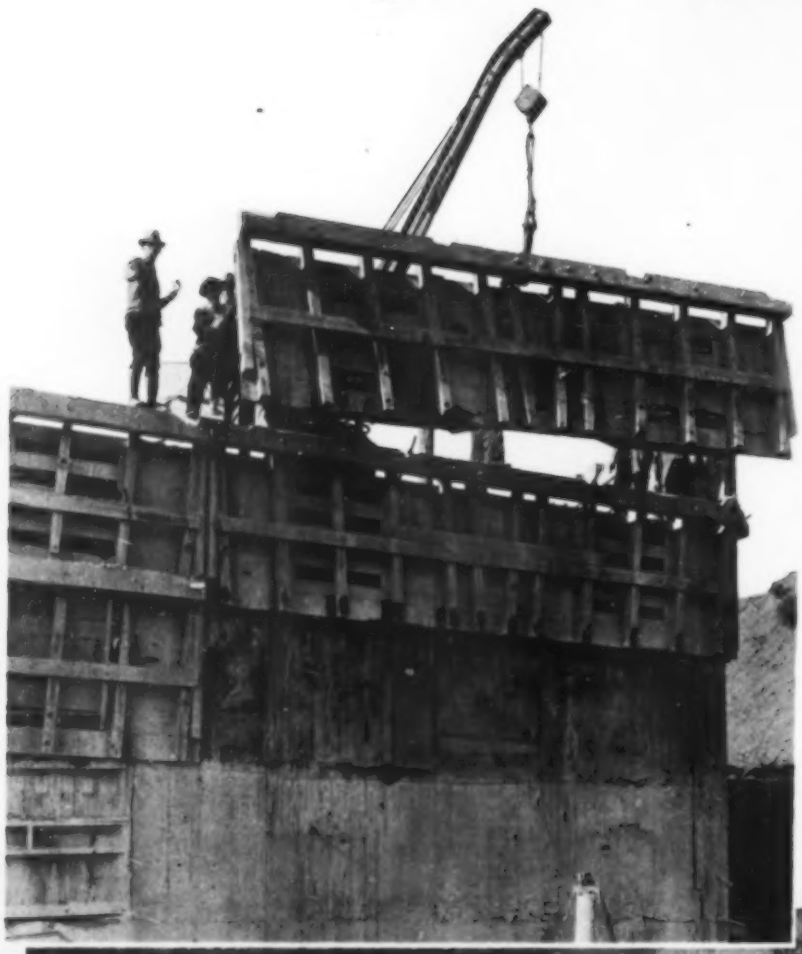




WINDROW SIZER produces uniformity in volume of continuous "ribbon" of material used in California for road-mix construction of bituminous surfacing. Equipment developed jointly by Resident Engineer Evans, of California Division of Highways, and Gardener Bros., contractors, consists of bowl *(left)* attached under frame of 9-ft. blade grader *(above)*. In back of bowl an orifice, with adjustable plate at top, is cut to produce windrow of correct size and shape as grader is hauled ahead. Wing extension, riding on shoe, cleans up material on one side of windrow while straight opening on other side permits excess material to roll out laterally, to be used, later, in sizing second windrow.

NORRIS DAM CONCRETE

Mixing and Placing Plants Synchronized to Produce



HOISTING freshly stripped form panel (*left*) with portable truck crane which operates on hardened surface of lift above.

RECENT RECORDS in placing concrete in the 1,000,000-cu.yd. Norris dam of the Tennessee Valley Authority on the Clinch River in east Tennessee reflect the combination of a modernly-equipped undertaking of this magnitude handled by specially-selected crews of labor under thoroughly experienced supervision. Original plans contemplated that from 50,000 to 60,000-cu. yd. would be placed per month, with a probable maximum of 75,000-cu. yd. So closely has the concrete mixing and handling plant been synchronized, however, that 83,634-cu. yd. were poured during last January, and in 24 working days of 23 hr. each in February 84,413 yd. were placed. This record was raised to 86,962 yd. in March, during which month one mixer was out of commission for a time for repairs.

For these three months the average rate was 3,493 cu. yd. per 23-hr. day, with a maximum output of 4,160 cu. yd. in one day. The latter figure means that 180 cu.yd. were mixed and placed every hour with three 3-cu. yd. mixers in the plant and two 1,900-ft. span cableway each handling a 6-cu. yd. bucket.

These records were made before the dam sections being poured had reached a height where they taper down much. The thrust-wheel type of cableway towers installed permits the latter, however, to be shifted with comparative ease. While original expectations were that only one cableway might be employed in the narrow sections toward the top of the dam, it has been found that the two cableways can deliver concrete to the same spot with practically no loss of time in shifting the head-towers sideways when the buckets are traveling between the loading and the discharge points.

Although the maximum sustained rate of placement of 180 cu.yd. per hour occurred when the two cableways were delivering concrete to two different points, with no shifting of the

EARLY STAGE of concrete pouring, showing general method of placing form panels on alternate sections in which lifts of dam are poured.

Poured by Cableways in 5-Ft. Staggered Lifts

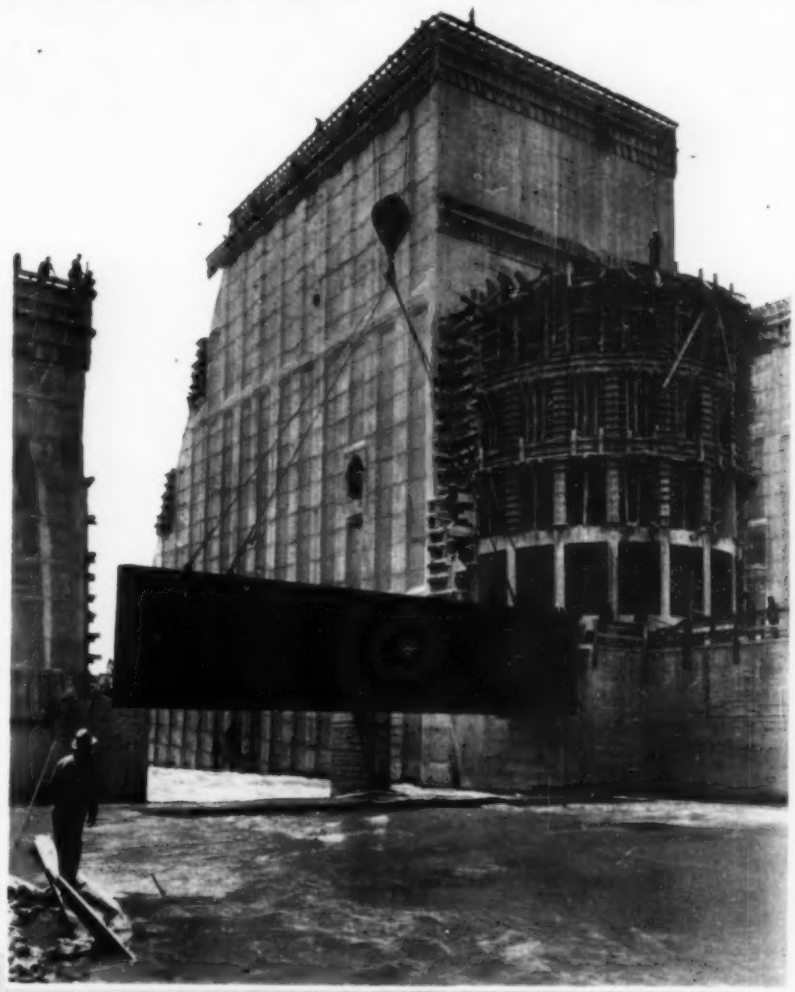
180 Yd. Per Hour—Concrete Vibrated in Panel Forms

towers necessary, a rate of 175 cu.yd. per hour is maintained when both cableways deliver concrete to the same spot. This means that both cableways may be used simultaneously to the end of the job. As a result, it is estimated that three months will be saved in the placement of the concrete.

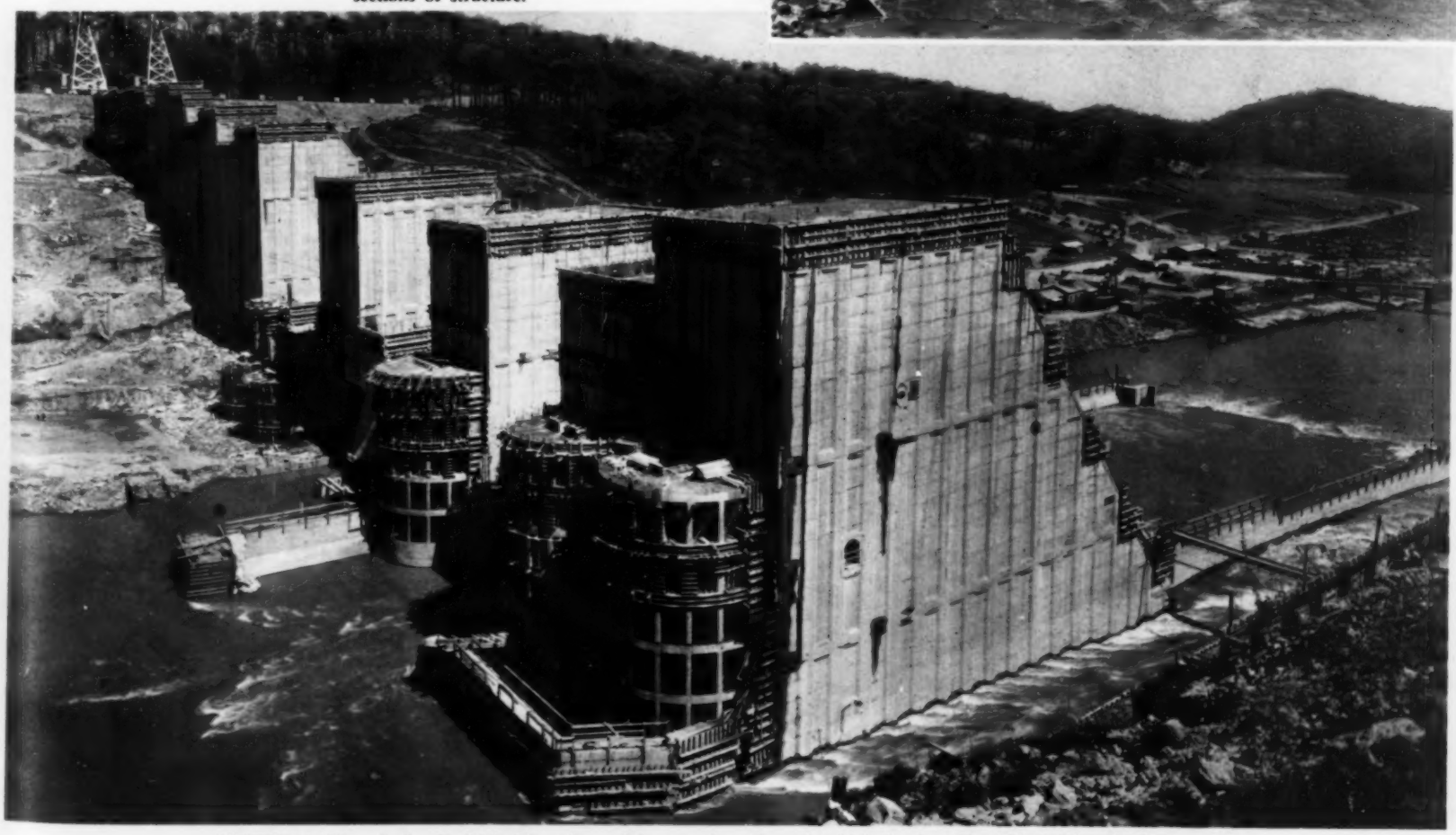
Sequence of Operations—Plans for placing concrete for Norris dam provide for carrying the Clinch River through the project. Provision was made to handle a maximum flow of 40,000 sec. ft. across the site during progress of the job. With the cableway system of handling it was possible to prepare the foundation and pour concrete in the stream channel within comparatively low-cost cofferdams. In the early stages topping of the cofferdams might have involved limited damage, since the few units of portable equipment in the latter could promptly be removed. Pumping out after the river dropped again and some cleaning up of silt would be the only expense. As a matter of fact, with one brief exception before much of a start had been made, no difficulties have been experienced from high water. During the latter part of March and early April flows of over 40,000 sec.-ft. were experienced with two peaks of close to 50,000 sec.-ft. with no resulting damage.

As a general policy the dam is carried up in alternate sections, and 56 ft. wide with the long axis of the dam and to the full contour of the two faces of the latter. Two 20-ft. steel penstocks extending through the dam are each in adjoining sections. These two penstock sections were not for a time carried up in sequence with rest of the dam, since some changes in design of the gates controlling them were adopted to make a delay on these sections necessary. Otherwise, the alternate-section plan has been followed from the beginning, concrete being poured in 5-ft. lifts.

After a lift is poured in a section it is permitted to set a minimum of 72 hr. before the next lift is placed on it. This



STEEL GATE (*right*), 60 ft. long, 11 ft. high and weighing 50 tons, is lowered into place between two sections of Norris dam. Concrete is poured in section protected by gate to bring it to level with other sections of structure.



NORRIS DAM ready for final blocking of remaining openings through which flood-swollen Clinch River has been rushing. River will then flow through eight sluiceways which penetrate base of dam.

Faster Hauls

THE NEW LOW COST WAY TO

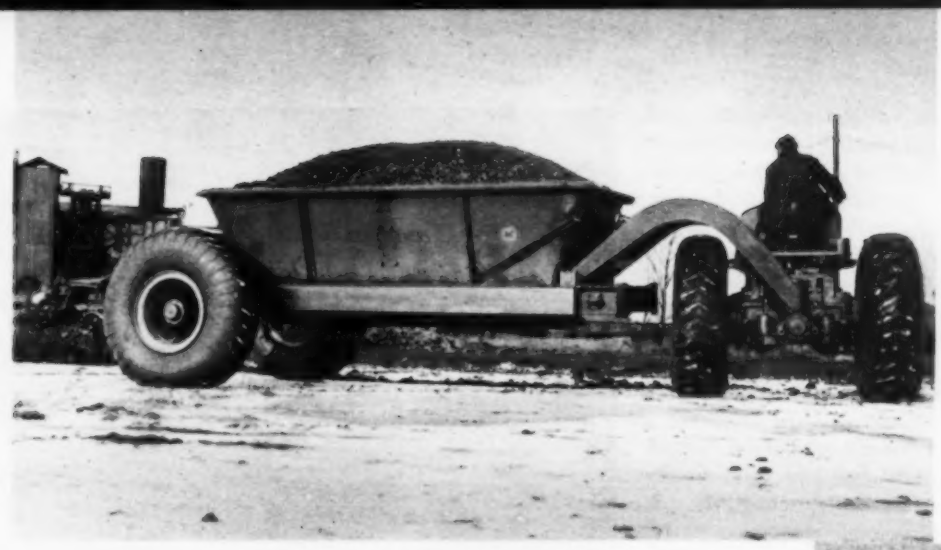
Here is something more than a new hauling unit ... it is an entirely new method of moving dirt ... at faster speeds and at lower cost than has ever before been possible. The new Allis-Chalmers Speedster hauls 6 to 8-yard loads ... at speeds ranging up to 16 miles an hour. Turns "on a dime" for quick easy spotting. Works anywhere ... in loose dirt, sand, gravel, rocks, gumbo, on steep slopes. Big, low-pressure tires roll over ruts and bumps, providing ample traction and efficient use of power. A single-unit hauling outfit ... designed and built specifically for dirt hauling ... powered by a proven tractor engine. Contractors who have used the Speedster say it beats anything they have ever seen for high speed dirt moving. Why not be among the first to take advantage of this better way to move dirt?

ALLIS-CHALMERS
TRACTOR DIVISION—MILWAUKEE, U. S. A.

...ling

...TO MOVE DIRT

ONE MAN UNIT. One man operates the entire Speedster unit. Braking, dumping and winding operations are vacuum controlled from the tractor dashboard. High clearance eliminates "hanging up" on the dump. Low hitch prevents tractor "raring". Cushion hitch provides stability with flexibility.



SHORT TURNING

Turns in its own tracks . . . at greater than 90 degree angles. Independent clutches and brakes permit quick spotting for loading and speedy action at the dump. High arch permits tractor to undercut.

TRACTIO

Big, low-pressure tires have large area in contact with the soil, providing ample traction for big loads, steep slopes and rough going. Exceptionally low hitch aids traction and ease of control.

SPEED

Hauls 6 to 8-yard loads at speeds up to 16 miles an hour. Four speeds forward — 2.5 to 3.7, 5.8, 10.5 and 16. Less dead weight means greater pay loads and higher speeds.

THE NEW SPEEDSTER

combination of alternate-section and staggered-lift pouring provides time for the heat generated in the setting of the concrete to be dissipated satisfactorily.

Form Construction and Handling—Before pouring of concrete was begun the decision was made to eliminate the vertical steps commonly used on the surface of each lift. To obtain the keying provided by such steps the surface of each lift is laid on a 5 per cent decending grade from the downstream to the upstream faces of the section of the dam. By finishing this slightly graded surface fairly smooth, the use of wheeled portable equipment on the hardened concrete of each lift is practical.

This plan of procedure in pouring the lifts permitted the adoption of a simplified system of standardized panel forms in sections that could be shifted by a portable crane operating on the surface of each lift. This scheme of operations eliminated need for any reliance on the cableways to handle forms, except occasional shifting of the crane, and now and then of sections of the forms. As a general thing, the forms for each section are carried up with it.

NIGHT SCENE at Norris dam where pouring of concrete goes forward without ceasing, resulting in remarkable construction progress record.

SPECIAL HOOK SWING from portable crane engages eye-bolt in form panel so that top of panel is pulled out to clear one above. No hand work required to strip panels.

All panels are 13 ft. 11¾ in. long. The upstream panels are faced with dressed 2-in. plank to a height of 5 ft. and those for the downstream face to a height of 5 ft. 10¾ in. The eight 3x6-in. studs to which the plank facing is spiked are battered on both sides of the vertical center line of the panel to prevent lateral movement of the panel by engaging the studs of the panel below that already is anchored to the hardened concrete of the previous lift. Bevelled 4x6s on both ends of the panel provide straight ends to fit properly with the abutting panels.

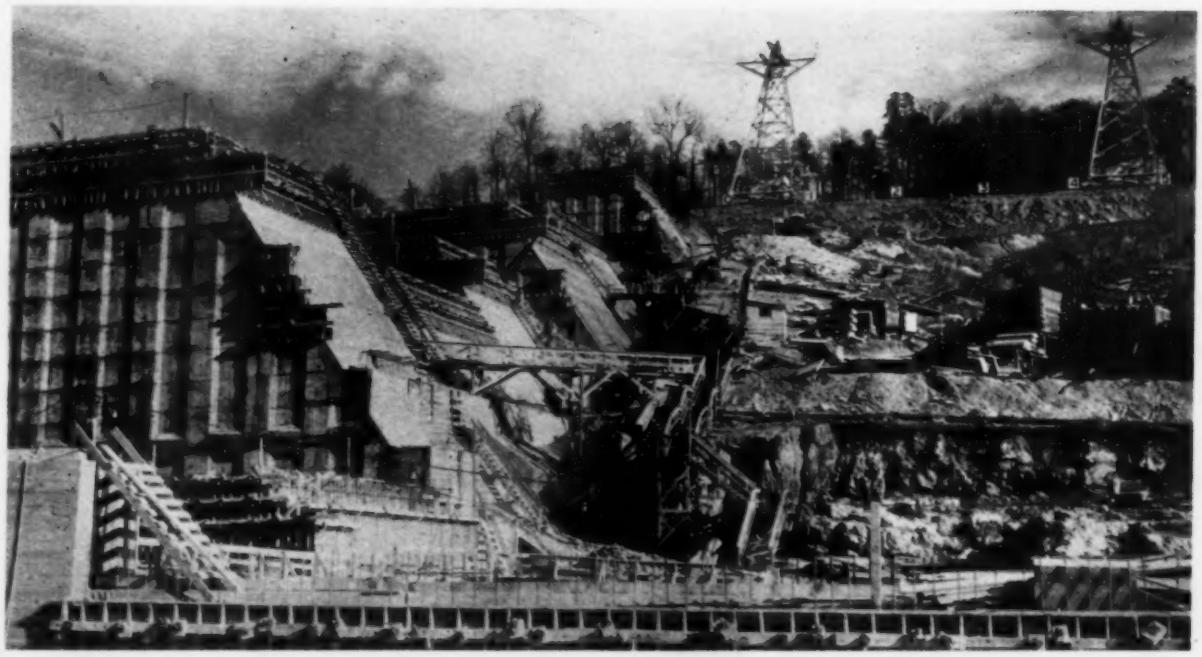
Anchored to the projecting top ends of the studs is an 8x6-in. waler which serves several purposes. This waler stiffens the ends of the studs and provides a means of anchoring the panel to the previously-poured concrete of the lift below. It also engages the bottom ends of the studs on the panel set on it above so when the panels are in place this waler is common to two.

Bulkhead forms between the sections in which the dam is poured are of the same design as those for the upstream and downstream faces, except each panel carries two 4-ft. vertical key spacings 6 in. deep. These bulkhead panels also are made right and lefthand. They slope from the upstream to the downstream end of the section to correspond with the slope left on the surface of each pouring lift.

Each panel is tied to ¾-in. anchors set in the previously-poured lift below it by four ¾-in. rods. The top end of each rod is threaded inside the form to engage a short section of internally-threaded rod extending through the

PORTABLE CRANE brings freshly stripped form panel up over one that was above it and sets it in position for pouring next lift.

CARPENTERS (*right*) tighten wing-nut on removable, internally-threaded section of anchor bolt, four of which hold tip of each panel in place. Wedged 1½-in. pipe spreader holds top of form out until concrete is half way up on lift.



CONCRETE PLACING AT NORRIS DAM, is done with two 1,900-ft. span cableways, each handling a 6-yd. bucket. Keyways are shown in relief in side of dam section.

8x8-in. waler of the panel. This piece of waler rod carries a wing nut and an OG washer with which the top of the panel may be drawn exactly to line. The top of the panel then is held in position by four 1½-in. pipe spreaders wedged in place at the top against the face of the panel and against the concrete at the bottom. These spreaders are removed when the lift is half poured. As an additional anchorage for the bottom of the panel, a row of four 1-in. sleeve rods is spaced horizontally 2 ft. from the bottom of the panel to hold the latter by means of ⅝-in. anchor rods imbedded in the concrete.

Each panel carries a 1-in. eyebolt set midway between the ends in the 8x8-in. waler. A specially designed hook on the fall line of the portable crane engages this eyebolt in handling the panel. This hook is made so it fulcrums against the form of the lift above in such manner as to tip the top of the panel slightly out from the face of the finished concrete as the crane hoists the load. No hand prying or pulling is required.

With this design of panel the only hand work necessary outside the forms in shifting the panels is the removal of the waler rods on the ends of the ties and the row of 1-in. sleeve rods. This is done by men in lineman's slings. Before the men are lowered over the side the crane hooks on the eyebolt. As soon as the waler rods are loose and the outside men are clear, the crane strips the panel from the concrete and hoists it to a position directly above the one already anchored over it. The shifting is rapidly and easily done with a minimum of labor. The panels fit true and firmly with no adjustments or jacking necessary. Panel alignment is readily attained and without exception accurately maintained.

Three-point support was provided for the portable crane with which the panels are shifted in order to insure stability on the rough concrete. Two of these cranes handle all of the panels on the entire job. They are quickly shifted from section to section by either of the cableways. The latter simply hook on to a wire-rope sling kept fastened to the frame of the crane and hoist and move the latter to the next section on which it is to work.

With more than half the 1,000,000 yd. poured when these notes were written, this type of form has proved to be entirely satisfactory. Except for rare damage to the facing plank from accidents in handling, no repairs have been necessary. Indications are that the limited number of panels required may be used to the end of the job.

Concrete Placing—Pouring of each 5-ft. lift is started at the upstream end of the section. The surface is built up to maintain about the 5-per cent slope on which the lift is finished. With the dry mix used and the large proportion of cobbles in the mix, special care is taken to obtain thorough compaction of each bucket load and complete blending with the loads previously placed with which the new load comes in contact.

Immersion-type vibrators are used to consolidate all concrete. On the average, about 1½ min. are required to compact a 6-cu. yd. batch of the relatively dry concrete used in the body of the dam enough to bring water to the surface so that there is the appearance of having employed a rather wet mix. The surface of each lift is smoothed off with a flat puddle-type vibrator.

Power for the vibrators is supplied by a separate motor-generator set with which it is possible to obtain a change in frequency. Experience has shown that 80-cycle current is more effective than 60-cycle for this service.

VIBRATORS of immersion type *(right above, and in circle)* compact dry concrete mix in areas containing heavy steel reinforcement. Vibration time is 1½ min. per 6-yd. batch.

At the present rate of progress it is estimated that Norris Dam proper will be completed before the end of December of this year. Storage of water will be possible some time before that. Since the flush flows of the Clinch normally occur between November and May, the full value of Norris dam in supplementing the usual low summer and fall flows at the main dams on the Tennessee River will be available in 1936.

Personnel—A. E. Morgan is chairman and chief engineer of the Tennessee Valley Authority. C. A. Bock is assistant chief engineer, C. H. Locher is construction consultant and A. J. Ackerman construction plant engineer. Barton Jones is engineer of construction and Ross White superintendent of construction on Norris Dam.

JOB ODDITIES

A Monthly Page of
Unusual Features of Construction

BANE OF AQUEDUCT SURVEYORS—Jerry, wire-haired mascot of Barrett, Hilp & Macco Construction Co., which is building a portion of Colorado River aqueduct, proved to be solution to mysterious disappearance of line and grade stakes set along aqueduct route in Division 2 by survey crews of the Metropolitan Water District of Southern California. Sleuthing by Division Engineer W. E. Whittier disclosed fact that Jerry trailed rod and transit crews, pulling up their carefully placed wooden stakes and burying them elsewhere in desert soil as if they were succulent bones.

MODEL OF BOULDER DAM is built to exact dimensions from engineers' drawings for display at California-Pacific International Exposition which opened at San Diego last month. Miniature structure, made by technicians of Los Angeles Chamber of Commerce and covering area of 20x40 ft., will impound 3,000 gal. of water. Model builder, in center, is placing one of the four intake towers on Nevada side of dam.

ADVOCATES OF "DIRECT LABOR" on public works projects should be heartened by this example of slow, wasteful hand methods in transporting concrete for a building in Keijo, Chosen, Japan.

DESERT "FERRY," *(below and at left)* in form of big 12-yd. bucket on Bucyrus-Monighan dragline operated by W. E. Callahan Construction Co. and Gunther & Shirley, contractors for 30 mi. of canal excavation involving 40,000,000 cu.yd., transports Ford automobile across All-American canal being built by U. S. Bureau of Reclamation in Southern California to deliver water from Colorado River to Imperial Valley.—*Photos from* R. B. Williams, *construction engineer, U. S. Bureau of Reclamation, Yuma, Ariz.*

JOB MANAGEMENT
IN ROAD BUILDING

Fourth of Six Articles Dealing With Factors That Affect Equipment Selection, Operation and Dependability, Production and Cost

–4–

Power Shovel Grading Operations

By J. L. HARRISON

Senior Highway Engineer, U. S. Bureau of Public Roads, Washington, D. C.

WITH occasional exceptions, which are of little real consequence from the standpoint of this article, power shovel grading in the highway field involves not less than three operations: (1) digging and loading by the shovel; (2) hauling by teams and wagons, trucks, or tractors and wagons; and (3) distribution on the dump by blade graders or bulldozers. To these three operations a fourth, rolling the material placed in the dump, is sometimes added. A fifth, the drilling and blasting of rock, is encountered frequently. Both of the last two operations are important on work where they are required, but as their management does not involve any principles not encountered where only the three first named must be executed, little mention of them will be made here.

"No amount of managerial ability can offset the effect that a poor shovel or too few trucks are certain to have on production and on production costs."

Since power shovel grading, therefore, involves three distinct major operations, each of which must be separately equipped, it should be evident that the first thing to be done to insure a satisfactory rate of output is to tool the job correctly. Preferably the size of the shovel sent to the job will correspond, in a general way, with the size of the project. In practice, however, this preference cannot be too exactly followed, for many contractors own only one machine or machines of only one size, or for some other reason find their choice of equipment limited.

Without regard to its size, the shovel which is to be used should be dependable. This is vital. If it is not dependable—that is, if time losses, a few minutes here and there, a breakdown now and then, are to be encountered—

SHOVEL DIPPER SIZE should "fit" the load-carrying capacity of the hauling units, which should be filled with whole, not fractional, number of dipper loads.

the direct loss of production these time losses will occasion will cause a corresponding reduction in the average production per work-dollar spent. By damaging or destroying organization morale they are certain also to cause indirect losses in production. In short, a poor shovel and a low production cost are not to be expected on the same job.

Production Rate—While a dependable shovel is the first step toward a satisfactory rate of production, the fact that, though the shovel may be in first-class condition, it cannot dig faster than the hauling equipment can move the diggings, cannot be overlooked. This means, first, the determination of a rate at which the shovel should produce material and, second, tooling the hauling operation to harmonize with that rate. This is the critical point in the development of an efficient grading organization—the point at which underproduction is most likely to develop. It, therefore, deserves discussion at some length.

The determination of the rate at which the shovel will be expected to produce must take the capacity of the shovel and the conditions under which it will work into consideration. As a rule it is not practical to attempt to obtain a full capacity rate of output from a shovel. For one reason, operators who can sustain such a rate are very hard to obtain. Moreover, if such a rate is set, other operations must be tooled accordingly. The losses which result from a failure to sustain the rate are then increased. For these and other reasons the rate of output is usually based on the amount a good operator can regularly obtain rather than on what a shovel is mechanically able to produce. However, the rate selected is of less importance than that the same specific rate be maintained, for the design of the whole construction organization depends on agreement on a rate of output the organization will be designed to support.

"Workmen are not disposed to shirk their recognized responsibilities. They do not stop merely to avoid activity. They stop because there is no apparent way of doing anything better."

CRAMPED QUARTERS. Insufficient working space causes loss of time for both power shovel and truck.

Size of Dipper—In determining the proper tooling of the hauling operation to support the selected rate of output, the first thing to consider is the relation of the size of the shovel dipper—that is, the average load it will pick up—to the load-carrying capacity of the hauling units. A ¾-yd. dipper will, for instance, pick up about 0.45 cu. yd. of ordinary excavation (measured in place). A 1¼-yd. dipper will pick up nearly twice that amount. A 1-yd. dipper will average not far from 0.65 cu. yd. to the load.

These are rather general figures, for

the "pick up" varies somewhat with the design of the dipper and more with the material that is being handled. However, they are accurate enough to bring out the first point to be made: *The hauling equipment which is selected should "fit" the size of the shovel—that is, it should be fully loaded by some whole number of average dipper loads.*

The writer's attention was first drawn to this requirement in a study of the average load placed on horse-drawn wagons by a ¾-yd. shovel. Over a considerable period and on several jobs this was found to be about 0.9 cu. yd. as measured in place in the cut. On elevating grader jobs similar wagons were given a load of from 1.2 to 1.3 cu. yd. The reason for the relatively light loading on the shovel jobs seemed to be that the wagons would carry two dippers full but would not carry three without a good deal of spillage. The result was that, on the average, the wagons went to the dump well over half a dipper full under-loaded, that is, utilizing it involves loading a fractional dipper full. Quite generally this situation results from the prejudice which shovel runners appear to have against giving hauling units a variable number of dippers full in order to obtain a full load, a prejudice they abandon quite reluctantly.

The cost of hauling is such a considerable part of the cost of grading that under ordinary circumstances it is poor economy to move vehicles under less than a full load. The first protection against loss here lies, then, in providing hauling units which should be fully loaded without requiring the shovel runner to dig fractional dippers full; and, second, in requiring shovel runners to put on a full load even though this may mean placing a variable number of dippers full of material on the hauling units as they come up to be loaded, as well as the use of fractional dippers full.

TYPICAL HIGHWAY GRADING SCENE (*below*), showing earth fill in foreground and deep cuts in background.

LOADING TIME MINIMIZED by spotting empty truck alongside unit being loaded, thus allowing the power shovel to work without interruption.

NORMAL WORKING SPACE allows trucks to be maneuvered easily and prevents delays by non-interference of incoming and outgoing hauling units.

with roughly a 75-per cent load. Evidently the cost of hauling the material moved was correspondingly higher than it should have been, or, to put the matter differently, to support the selected rate of output at the shovel a correspondingly greater number of wagons had to be used.

"Though the shovel may be in first class condition, it cannot dig faster than the hauling equipment can move the diggings."

This matter is not so apparent where trucks or tractor-drawn wagons are used for, as a rule, they carry more than two dippers full, but rather more often than might be supposed the load-carrying capacity of these vehicles is not fully utilized on shovel jobs because

Hauling Equipment — If a satisfactory rate of production is to be attained, it is necessary to provide a style of hauling equipment suited to the working room that will be available. No shovel can work at capacity unless it always has a place to put the material it digs. On an ordinary highway grading job this material must be loaded into hauling units of some sort. Inevitably, then, if the shovel is not to be delayed, it is necessary that the loaded vehicle pull out and the empty vehicle pull in within the period the shovel operator requires to load the dipper. On a fast job this means an exchange of vehicles in a period of about 20 sec. Even on a slow-moving job this period does not exceed 30 sec.

To make this exchange within as short a period as this—and it must be done within this period if production is to be fully maintained—the hauling units must be capable of easy manipulation within the working space that is available. In a restricted working space, such as a relatively narrow cut, relatively small hauling units are, for this reason, preferable to large hauling units. This means that in locations of this sort teams and wagons, light trucks and such special units as the "dumper" are to be preferred to heavier hauling units. The latter require so large a turning radius that in narrow cuts and in other situations where the working space is restricted a good deal of time is lost in getting them into position under the shovel.

Time lost in this way may easily be overlooked, because each loss is small and the fact that it is repeated hour after hour and day after day escapes notice. The writer has studied a number of jobs in narrow cuts where large trucks were used as hauling units. On one of these, to get the trucks into position, they had to be turned some 300 ft. from the shovel and backed into place after the loaded truck had pulled out. The loss in operating time which resulted was large, as an exchange in hauling units usually took well over 1 min. Taken individually these losses did not appear so large, but when summarized for a day they resulted in an important subtraction from the working day.

On this particular job four dippers full were placed on each truck. This took about 1 1/3 min. The loss of over 1 min. in getting the loaded truck out and the empty truck in left the shovel inactive almost 50 per cent of the time. That production was low is not at all surprising. It could not have been otherwise in the face of the loss of so large a fraction of the working day. Unfortunately, conditions of this general nature are not unusual.

Ground Conditions—The nature of the ground over which hauling must be done governs the speed at which vehicles can be moved. Poor ground conditions and low speed are inseparable, while good ground conditions tend to encourage normal or high rates of hauling speed. If the tooling of the hauling operation is based on one rate of travel and a lower rate is established by ground conditions, the tooling of the hauling operation is at once rendered inadequate, with a corresponding loss in production.

"It is not desirable to attempt to run hauling units at high speeds to offset under-tooling of the hauling operation."

The logical deduction from this observation is that probable ground conditions should be taken into consideration in the selection of the vehicles to be used for hauling. It is, for instance, a well-recognized fact that heavy hauling units require fairly solid ground

under them in the absence of which rutting will seriously reduce the speed at which they can be operated. It is easier to maintain satisfactory ground conditions where dual-tired trucks are used than where single-tired trucks are used. Normally, crawler-type tractors do still less damage to the traveled way if this is of natural soil. These matters are, perhaps, too obvious to require much discussion. Still the fact remains that, in practice, they receive less consideration than they deserve, for ground conditions are not always equally satisfactory for all types of hauling equipment and wherever it is known in advance that they are likely to be subnormal, the selection of a type of hauling equipment that is suited to the conditions to be encountered is quite certain materially to improve average production.

"The hauling equipment which is selected should fit the size of the shovel—that is, it should be fully loaded by some whole number of average dipper loads."

Some years ago the writer had occasion to study a paving job for which large trucks had been provided as hauling units. Hauling had to be done over a fresh subgrade that appeared to be in good condition. Enough trucks were provided to support placing pavement 5 mi. from the materials yard at the rate of about 800 lin. ft. per day. This rate was obtained on the first day, but in spite of the steadily shortening haul distance it fell the next and the next and within a week was down to about 600 ft. per day. In this case the sole reason for the reduced rate of production was the condition of the ground over which the hauling was done. The subgrade was rutting progressively under the heavy trucks that were being used and this rutting was reducing the speed at which the trucks could travel. Similar conditions produce similar results on grading jobs.

Width of Fills—The width of the fills also has a bearing on the selection of hauling units. Vehicles must pass each other at frequent intervals and must turn around either before backing to the point at which the load is deposited or after it is dropped. Narrow fills are not as common in the highway field now as they were ten years ago, but even now a good many jobs, particularly on secondary road systems, provide a restricted working space on the fills. Almost any sort of hauling equipment can be maneuvered without much loss of time where the fills are 40 to 60 ft. wide, as they often are on heavy trunk-line construction. But where the fills are under 30 ft. in width, as is commonly the case on light traffic roads, the working space is so restricted that large hauling units must be handled cautiously. The loss of a good deal of working time is the not uncommon result.

These comments may be summarized by the general statement that if a satisfactory rate of production at a proper cost is to be obtained the hauling operation must be tooled to meet working conditions as well as for theoretical capacity of output. On a great many jobs production is low or unduly expensive merely because the conditions under which the hauling units must work have not been given sufficient consideration.

Distribution at Dump—The distribution of material on the dump is the third operation in the grading series. There is little tendency to under-tool the dump, with the result that production seldom is retarded because too little equipment has been provided. An exception of some importance may be encountered when the material placed in the dump must be spread in thin layers and then rolled. Rolling is, of course, a separate operation, but spreading is a part of the third operation, distribution at the dump. As this sort of spreading involves a good deal more work than more ordinary practices impose, additional equipment may be required, as well as the extra equipment the rolling requires. If sufficient spreading equipment is not provided, or if the number of rollers provided is inadequate, conditions on the dump can, and occasionally do, retard production.

The above comments cover the more important aspects of tooling a grading job for a predetermined rate of production. This is, perhaps, the most important phase of the management of highway grading, and the one which, in the writer's opinion, receives the least attention. True enough, the fact that a job has been properly tooled does not guarantee a satisfactory rate of production. However, it should be clear that unless the job is properly tooled a satisfactory rate of production simply cannot be secured. No amount of managerial ability can offset the effect a poor shovel or too few trucks are certain to have on production and on production cost. Until corrected, it stands as an unsurmountable obstacle to satisfactory production and one that is uncorrectable by any other device than the substitution of correct tooling.

"Sending out too much hauling equipment generates lost time for the hauling equipment; sending out too little generates lost time at the shovel."

From the production standpoint, once the job is correctly tooled, job management becomes largely a matter of working the various units of equipment at the proper rate. In the grading field this involves major attention to two matters: (1) the speed at which vehicles move and (2) the elimination of unproductive delays.

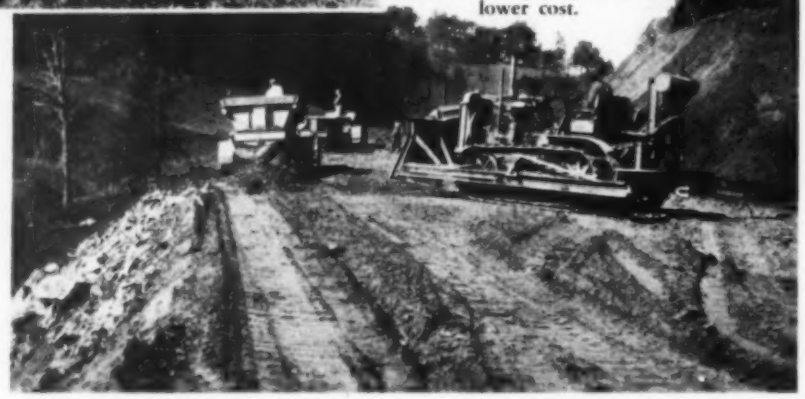
Hauling Speed—It has already been noted that the speed at which vehicles move is considerably influenced by the condition of the roadway over which they must travel. This fact suggests the desirability of a great deal of effort to keep roadways in such condition that normal travel speeds can be maintained. Often it seems a needless expense to keep the floor of the cut smooth, to blade roadways and to keep the dump leveled off. Sometimes it may be just this but, more often, a considerable expenditure in this field is justified by the

LIGHT LOAD is handled by this truck because body is not equipped with tailgate to insure full carrying capacity.

TOO MUCH HAULING EQUIPMENT at shovel, resulting in loss of equipment time and extra equipment cost.

CAPACITY OUTPUT FOR SHOVEL is possible only if arrival of hauling units is coordinated so as to prevent delays in loading time.

HAND LABOR *(left)* used to be employed for spreading layers of earth fill but modern practice uses tractor-operated bulldozer *(below)* to do the work more quickly and at lower cost.



higher production that is had when vehicles can travel at a normal speed, to say nothing of the fact that poor road conditions generate a high rate of repairs unless the hauling units are carefully, even cautiously, handled and if they are, hauling speed inevitably is reduced wherever road conditions are poor.

It is not desirable to attempt to run hauling units at high speeds to offset under-tooling of the hauling operation. Wear and tear and breakage soon generate an even higher cost than reduced production generates. The practice of speeding up hauling units to offset under-tooling is of doubtful advantage. In the long run the best results are always to be had by operating the hauling units at the correct speed, road conditions being considered, and then making every reasonable effort to maintain road conditions under which a normal speed of operation is the correct speed.

Delays—Constant attention must be given to the elimination of waits and delays. As in the case of maintaining a proper operating speed, the matter here is not so much one of giving orders as it is of developing proper working conditions. Workmen are not much disposed to shirk their recognized responsibilities; they do not stop merely to avoid activity. They stop because there is no apparent way of doing anything better. Once stopped, they remain so until there is apparent reason for proceeding. Thus the amount of time that is lost in waiting and delays is not a measure of the efficiency of the men but a measure of the efficiency of the management in eliminating conditions which make stopping the obvious thing to do.

The correct tooling of a grading job eliminates the cause of a large number of the delays which are to be observed on most operations of this sort. However, at least in the highway field, the haul distance varies so widely from day to day that the amount of hauling equipment which should be sent out to keep the job in balance must be similarly varied from day to day if economy as well as efficiency is to be attained. Sending out too much hauling equipment generates lost time for the hauling equipment. Sending too little generates lost time at the shovel.

SIDE-DUMP WAGONS *(below)* facilitate discharge of material to place in high rock fill. Bulldozer *(in background)* aids in spreading the material.

MAINTENANCE *(left)* of smooth surface on hauling road serving power shovel speeds operation of trucks. RUTTED ROAD *(above)* delays trucks and causes lost time at shovel.

It is a well-recognized fact that it is not good policy to provide enough hauling equipment to keep the shovel busy in those exceptional cases when the haul distance is excessive. Standby charges on expensive equipment preclude this. Some lost time at the shovel is, therefore, to be expected even when a highway grading job is properly tooled. But aside from such lost time as must be accepted here, most lost time can be avoided if the successive operations the job involves have been properly tooled, with working conditions definitely in mind.

As noted above, lost truck time due to waits and delays usually means either that too many units have been sent out or that, in some particular, ground conditions interfere with the prompt manipulation of the hauling units. The losses in this latter field are much larger where the hauling units have been selected without regard to working conditions. Still, even when the hauling units are the best that can be had for the working conditions which prevail, there will be some delays unless the drivers are carefully instructed as to how the units are to be maneuvered and unless a good deal of attention is given to maintaining proper working conditions at the shovel and on the fills.

Discipline — Finally, the development of a smooth running organization requires normal attention to discipline. Given proper tooling and proper managerial attention to the maintenance of satisfactory working conditions, the job can run smoothly. Most employees desire to do their work properly. The first step toward proper discipline is taken when the manner in which specific details of the work are to be handled is fully explained to the workmen. Most workmen will take an active interest in full cooperation with the management in following understandable instructions. A few men will fail to understand, think it unnecessary to obey or deliberately disregard instructions. Such men should be eliminated promptly. The selection of men willing to follow instructions is the key to good discipline. Having obtained such men, the job should run smoothly and will run smoothly if the management has met its responsibilities which always include giving correct, understandable instructions to the men.

❖

NEXT MONTH — Continuing this series on Job Management, Mr. Harrison will discuss in the July issue "Concrete Pavement Construction."

Present and Accounted For —

A Page of Personalities

HIGHWAY CODE ADMINISTRATOR. Robert E. O'Connor *(below)*, member of firm of J. C. O'Connor & Sons, road-building contractors of Fort Wayne, Ind., has been named chairman of the Administrative Committee for Chapter II-C, Highway Contractors' Subdivision of the Construction Code.

LAKE OKEECHOBEE LEVEE BUILDERS. Army* and civilian engineer personnel at Florida flood control and navigation project, described elsewhere in this issue: *(Left to right)* Lt. R. Selee, Capt. N. L. Hemenway, Lt. George Kumpe, Col. G. B. Hoffman,* Lt.-Col. B. C. Dunn, Col. W. J. Barden,* Col. T. H. Jackson,* Assoc. Eng'r. Mark Lawler, Col. W. T. Hannum,* Const. Supervisor Gayle McFadden, Col. Earl I. Brown,* Engineer Carawan Nelson. *(*Member, Board of Engineers for Rivers and Harbors).*

H. H. HOUK, formerly bridge engineer, has recently been promoted to chief engineer of the Alabama Highway Department.

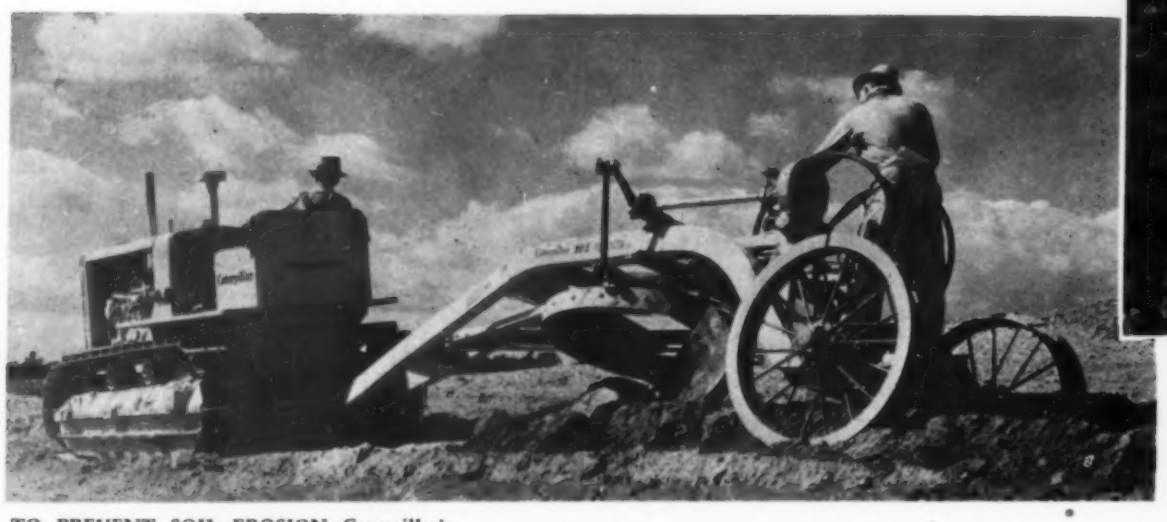
PENNSYLVANIA'S NEW HIGWAY CHIEF. H. H. Temple, former chief engineer of the Pittsburgh & West Virginia Railway, is the newly appointed chief engineer of the Pennsylvania Highway Department, succeeding Samuel Eckels. Mr. Temple has had a long and varied exgineering and construction experience in the railroad field, having served with the C.C.C. & St. L. Ry. as assistant engineer, with the B. & O. R.R. as division engineer and with the P. & W.Va. Ry. as general superintendent and chief engineer, in charge of an extensive program of main line improvements. From 1933 to 1935 Mr. Temple served as Eastern Regional Director and assistant to Joseph E. Eastman, Federal Coordinator of Transportation.

CITED FOR SERVICE. William Bewley, tunnel mucker at Thousand Palms Camp on Coachella Division, is holder of record for longest uninterrupted service on Colorado River aqueduct, California. Bewley started work at Thousand Palms Jan. 16, 1933, and in the 25 months which elapsed up to Feb. 15, 1935, had never missed a single shift other than those for regular layoffs.

A.R.E.A. PRESIDENT. Robert H. Ford *(right)*, assistant chief engineer, Chicago, Rock Island & Pacific Railway, has been elected president of the American Railway Engineering Association. His construction experience includes service as chief engineer, with the Hodge-Downing Construction Co., general railroad contractors, of Birmingham, Ala.

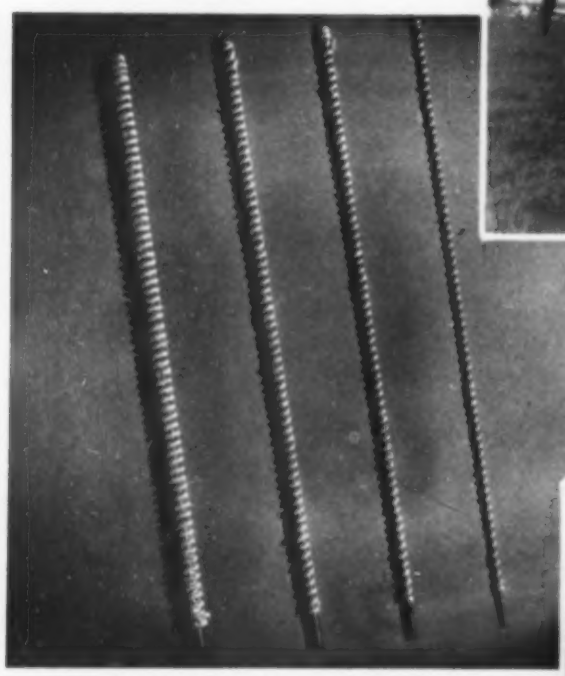
New Equipment on the Job

SAFE BLASTING AGENT, called Nitramon, for use in quarrying and stripping operations, looks like caked table salt and, according to its manufacturers, is no more hazardous to handle. When detonated by high-explosive primer it rates 20 per cent stronger than T.-N. T. Packed in airtight cans of various sizes. Photograph shows can of Nitramon riddled with bullets without causing explosion.—E. I. du Pont de Nemours & Co., Wilmington, Del.



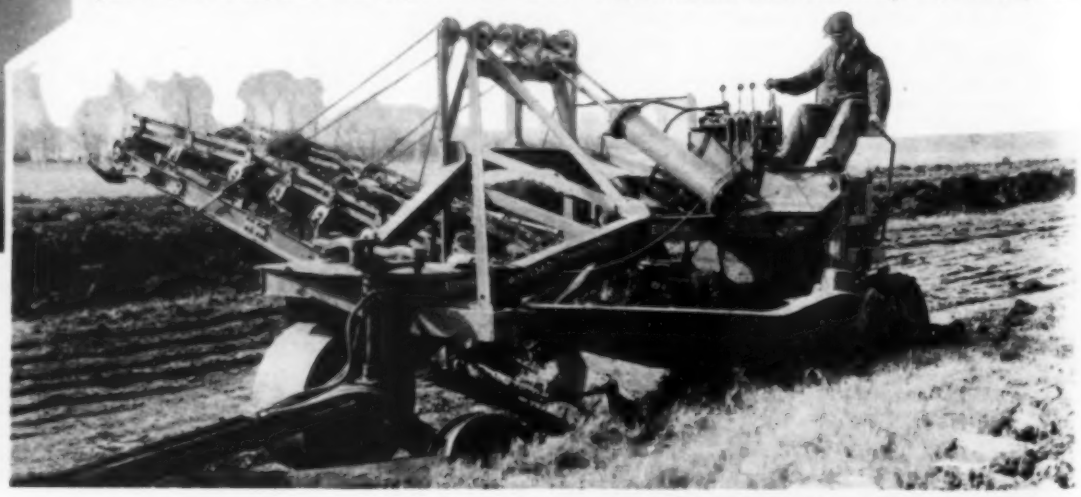
TO PREVENT SOIL EROSION Caterpillar's Terracers Nos. 1 and 2 have blades especially designed to meet terracing requirements. These blades have following advantages: (1) Curved to roll—not push—furrow of earth and to deliver it with least resistance in shortest time. (2) Made of high carbon steel material that scours well when working in wet and sticky soil. (3) Extra thick to give ample strength and stiffness without need of reinforcing on back. (4) Securely held to blade beams by 1¼-in. diameter steel pins at bottom and pitch adjustment straps at top, the latter allowing suitable setting of blade. No. 2 Terracer, (for use with 35- to 40-hp. tractor, has standard 10-ft. blade 1 1/16 in. thick; 8- and 9-ft. blades also are available. No. 1 machine, for lighter work, is powered by a 15- to 20-hp. tractor and has an 8-ft. blade.—Caterpillar Tractor Co., Peoria, Ill.

TRACTOR DERRICK *(left)*, high-speed, lightweight, portable machine for lifting or moving materials and equipment in field. Can be taken almost anywhere tractor can go and can be operated wherever tractor can get solid footing. Readily and quickly detached from tractor. Powered by regular Le Tourneau unit used to operate other equipment. Tractor operator controls derrick, one lever operating to change height of boom and other to take in or pay out lift line. Capacity 10,000 lb. and up, according to height of boom. Boom length, 20 ft. Tractor size required, 60 hp.—R. G. Le Tourneau, Inc., Peoria, Ill.

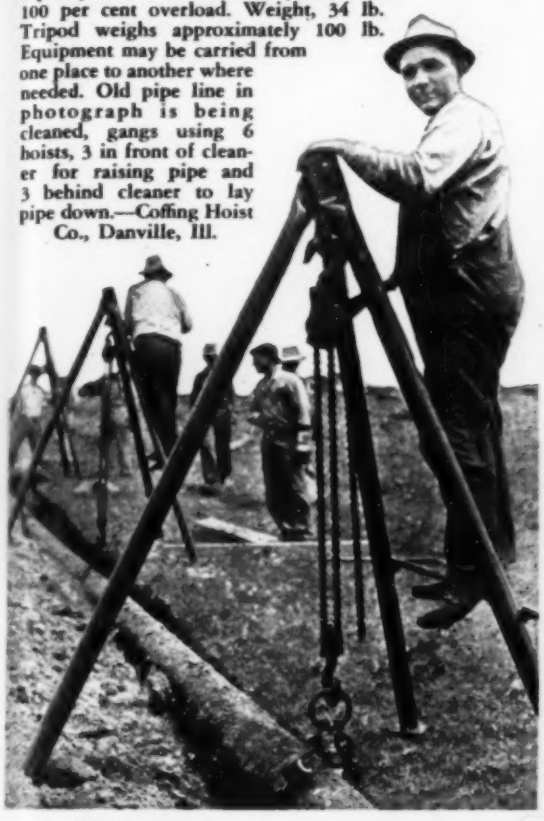


ALL-MINERAL COATED welding electrodes include patented spiral winding of asbestos yarn which is noncombustible and anchors extruded coating to core wire so that it doesn't crack off when electrode is bent. Winding also assures uniform thickness of coating and prevents wandering of arc when welding. Murex line comprises electrodes for flat welding, vertical and overhead welding and fillet welding of mild steel; for welding of manganese and stainless steels and for hard surfacing and building up worn parts.—Metal & Thermit Corp., 120 Broadway, New York City.

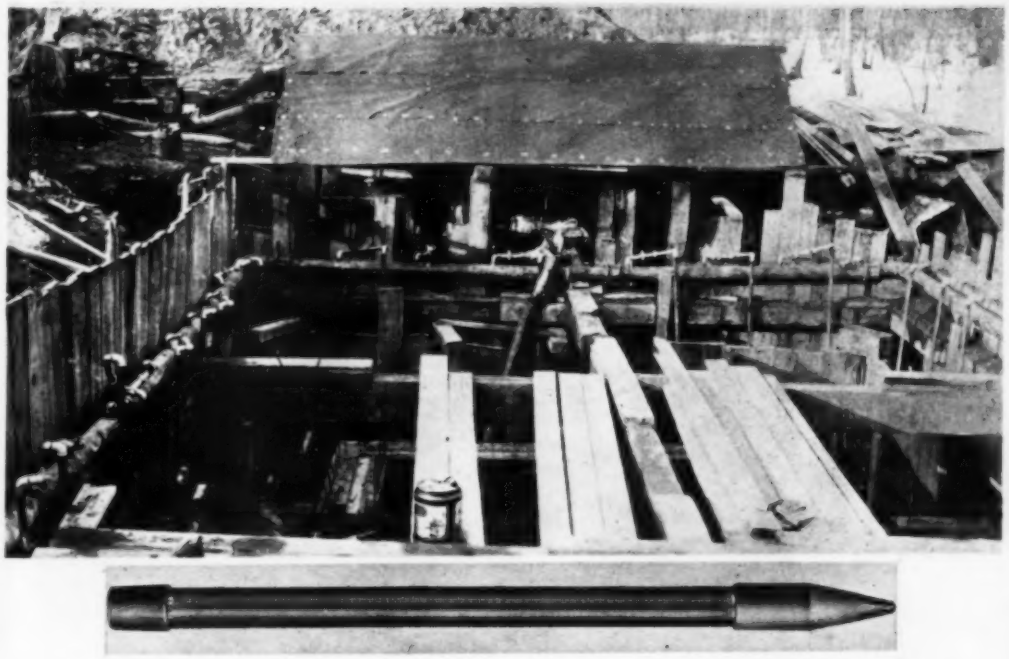
THREE-WHEEL ELEVATING GRADER *(below)*, hydraulic power-operated unit, provides increased capacity, regardless of ground worked, by combination of weight distribution, elevator design, plow-beam control and steering. One-piece welded steel frame is supported on three wheels, counterbalancing weight of full loaded elevator so that 32-in. disk plow can be forced down and worked to maximum capacity. Elevator, equipped with anti-friction rolls and troughed belt, driven at high speed by universal shaft, gets material away from plow as fast as it is dug. Stiff-leg plow has extra strong beam arched directly ahead of it to eliminate choking when handling sod or large clods. Hydraulic controls raise, lower or hold elevator and plow in any position.—Austin-Western Road Machinery Co., Aurora, Ill.



RACHET LEVER-TYPE HOIST used for handling pipe lines in oil fields has capacity of 3 tons with safety factor of 100 per cent overload. Weight, 34 lb. Tripod weighs approximately 100 lb. Equipment may be carried from one place to another where needed. Old pipe line in photograph is being cleaned, gangs using 6 hoists, 3 in front of cleaner for raising pipe and 3 behind cleaner to lay pipe down.—Coffing Hoist Co., Danville, Ill.



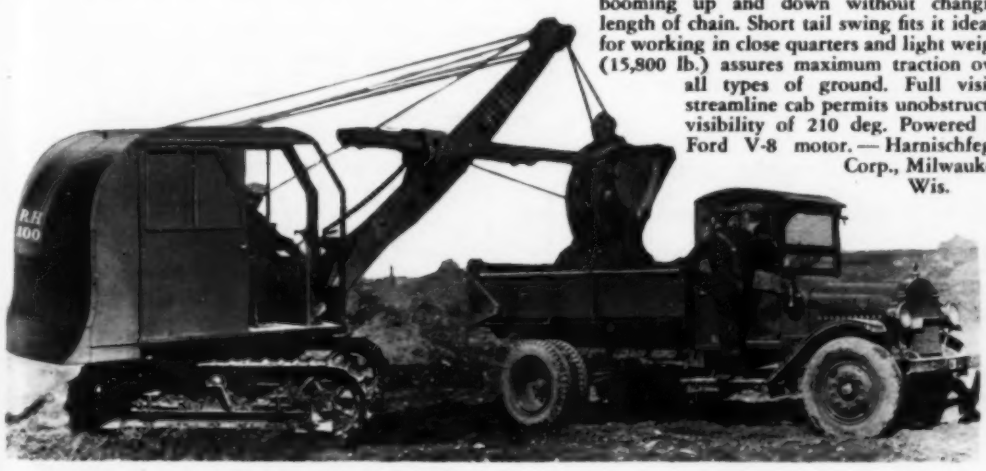
FAST, DEPENDABLE AND FLEXIBLE are three adjectives used by manufacturers in recommending to construction men their new bulldozer model, Roadbuilder, *(below)* and they back up their assertion by enumerating following structural advantages: — (1) Method of mounting saves wear and tear on tractor; (2) extra high lift of blade useful in clearing operations; (3) double-acting hoists provide downward pressure on blade for digging or breaking hard spots; (4) in addition to bulldozing position, blade may be set in right and left casting positions; (5) one end of blade may be raised above other, enabling operator to dig an insloped bench along hillside sections.—Gar Wood Industries, Inc., Detroit, Mich.



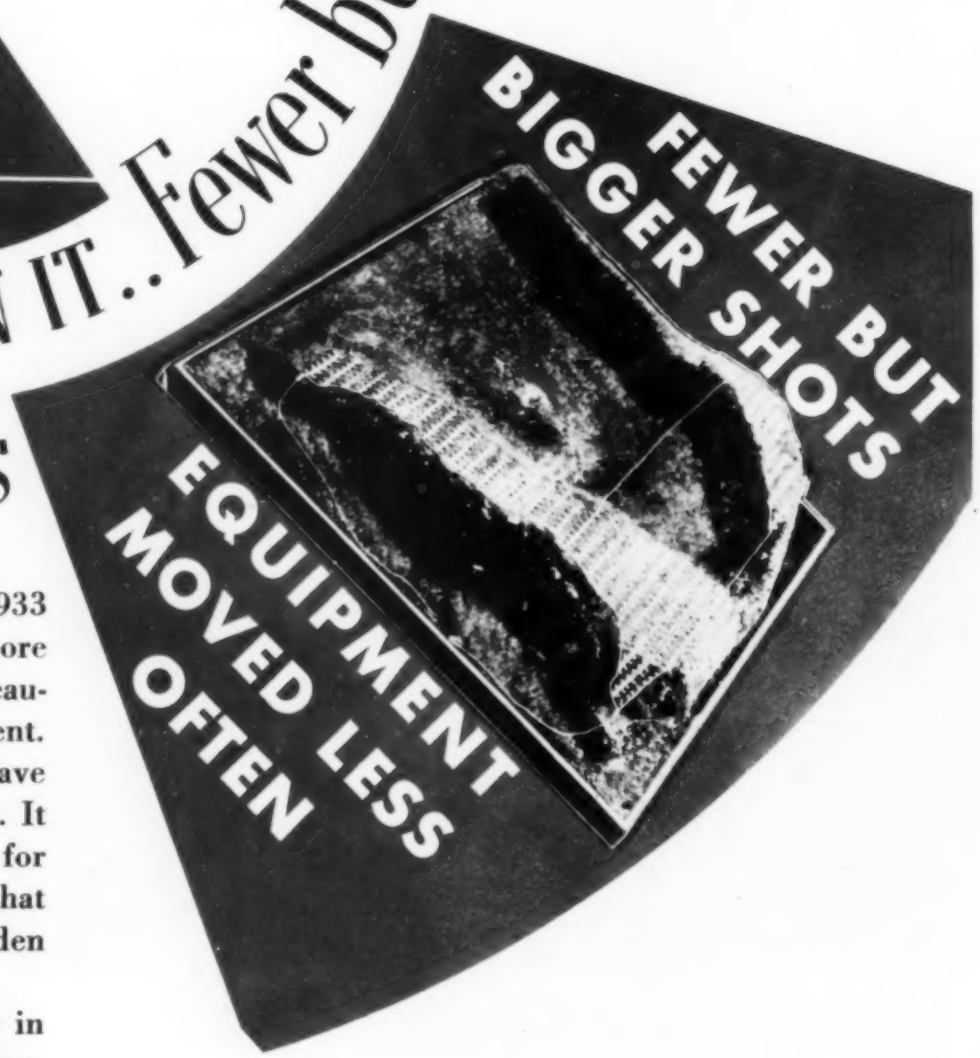
WELLPOINT SYSTEM *(left)* eliminates necessity of digging sumps or wells and offers points with two types of jetting heads, nozzle for sand and Jet'N Drive adapted for use in gravels, clay and hard subsoils. Other features: (1) Heads are of one-ball design, permitting easier sinking and quicker cleaning without pulling. (2) "Interflow" provides proper flow of water between drainage channels and prevents blocking. (3) Streamline construction, well point having same outside diameter as oversize riser pipe, thus decreasing friction loss and insuring complete salvage.—Griffin Wellpoint Corp., 60 East 42nd St., New York City.

POWERFUL TRACTION TIRES *(below)* of "ground grip" type prevent skidding and stalling in all kinds of rough work, including mining and construction operations. Tread has tremendous grip, will not clog up and rides smoothly. New tire equipment shown on International truck and Western-Austin trail car in big coal-stripping operation at Danville, Ill.—Firestone Tire & Rubber Co., Akron, Ohio.

FAST OPERATION, speedy travel, easy steering, climbing and quick turning have been the aims set in producing "Bantamweight," a new ⅜-yd. convertible excavator *(below)*. Standard swing speed is 5 r.p.m. with P&H split second clutches for easy control, fast starting and stopping and quick spotting of dipper. Live boom chain crowd mechanism permits booming up and down without changing length of chain. Short tail swing fits it ideally for working in close quarters and light weight (15,800 lb.) assures maximum traction over all types of ground. Full vision streamline cab permits unobstructed visibility of 210 deg. Powered by Ford V-8 motor. — Harnischfeger Corp., Milwaukee, Wis.



YES WE MEAN IT .. Fewer but Bigger Shots



Manistique made history in 1933 with a giant blast comprising more than 4,000 six-inch holes. Cordeau-Bickford was the detonating agent. It carried a powerful detonating wave to every cartridge in each load. It also provided a *positive* hook-up for all holes in a planned rotation that resulted in successive relief of burden —and better fragmentation.

Bigger shots also save money in time, in labor, and in wear and tear on machinery and equipment. With shots planned to include groups of holes, drilling can proceed without the frequent interruptions that accompany small blasts. Equipment can remain on the scene until all holes are drilled, instead of being repeatedly removed or covered to make way for smaller shots.

Yet bigger blasts—fewer, more economical and more profitable blasts—are only one way in which Cordeau-Bickford saves money . . . Learn about its other cost-saving features. THE ENSIGN-BICKFORD CO., *Simsbury, Conn.* Estab. 1836.

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another CLYDE WILEY-WHIRLEY

.... HELPS TO MAKE CONSTRUCTION HISTORY

The Central Engineering Co. of Davenport, Iowa, are using this barge mounted, steam operated, Clyde Wiley-Whirley on the Mississippi River Dam, No. 16.

Built to cope with the ever increasing demands for better and more efficient equipment, Clyde Wiley-Whirleys are the popular choice of leading contractors and engineers everywhere.

For your own particular needs, on construction jobs or industrial work, let us send you recommendations and specifications for a Clyde Wiley-Whirley that will increase production and lower costs.

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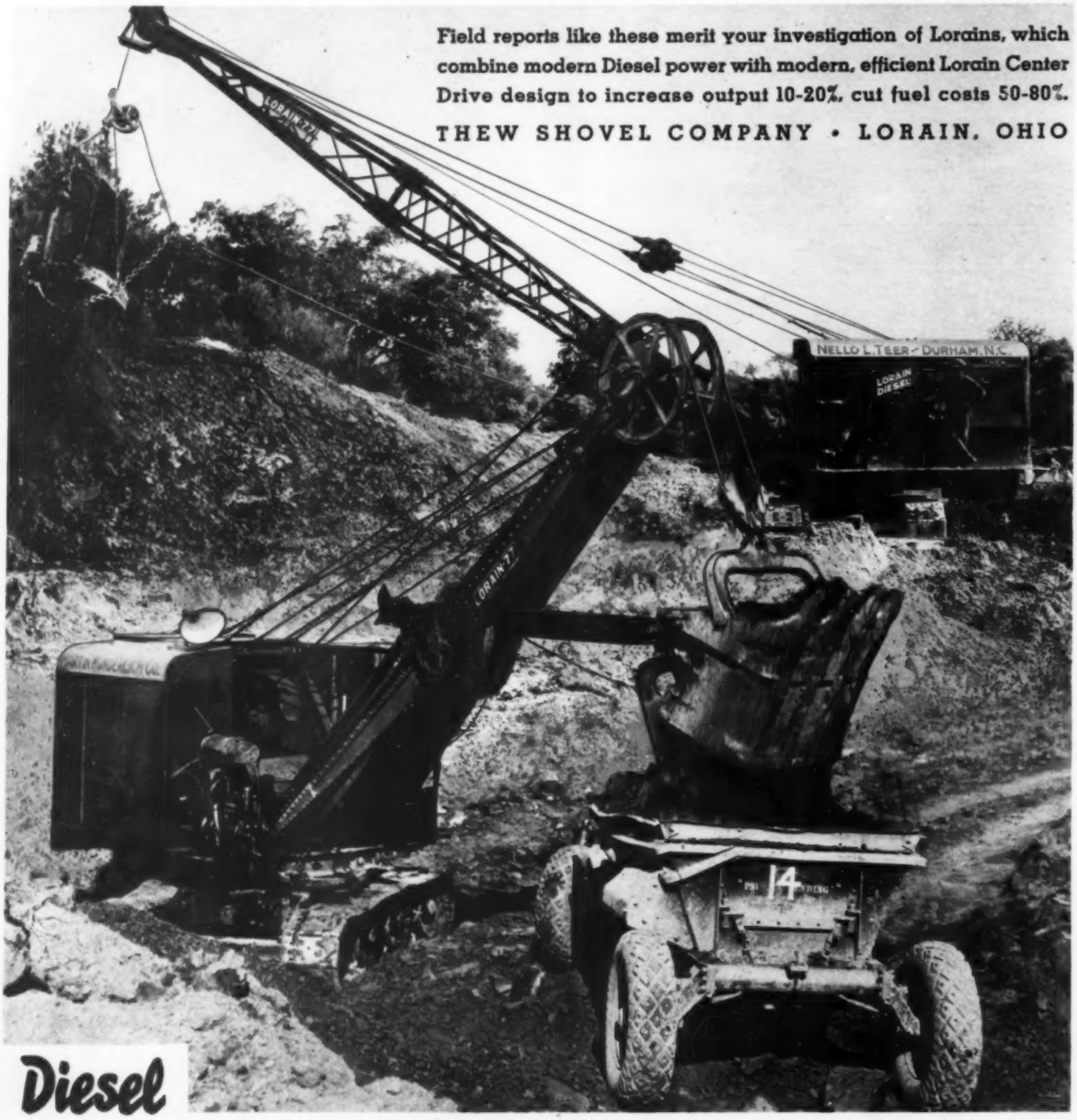
● "Daily production was 2052 yds. . . . on 27 gals. of Diesel fuel in 8 hrs". . . "Operated shovel 240 hrs. on 850 gals. of fuel oil". . . "We averaged 2000 yds. in 10 hrs. . . . at a fuel cost of $2.55". . . "We find the Diesel shovel has more power, travels and swings faster" . . . "Our production justified your claim of 10% increased production" . . . "I'd say 20% was not far off because the harder the digging, the easier it is for this machine to increase this percentage". . .



Field reports like these merit your investigation of Lorains, which combine modern Diesel power with modern, efficient Lorain Center Drive design to increase output 10-20%, cut fuel costs 50-80%.

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Diesel

LORAIN (THEW CENTER DRIVE) **77** 1½ YARD · **75D** 1¼ YARD · **55** 1 YARD · **45** ¾ YARD

A POINT worth thinking about

The photograph focuses attention on an important advantage of I-Beam-Lok bridge flooring. The conservative design of I-Beam-Lok provides close spacing of main beams and transverse bars. The small rectangular spaces formed and the strength of the main beams permit the safe operation of trucks and concrete mixers on the unfilled units as soon as they are attached to bridge stringers. This eliminates the need for temporary floors or planking for delivering concrete and materials to the job.

Your finished installation is an armored concrete, anti-skid, long-life wearing surface, free from possibility of the progressive development of large surface cracks. Investigate the many advantages of I-Beam-Lok. Consult with our engineers or send today for descriptive literature.

326

CARNEGIE STEEL COMPANY PITTSBURGH

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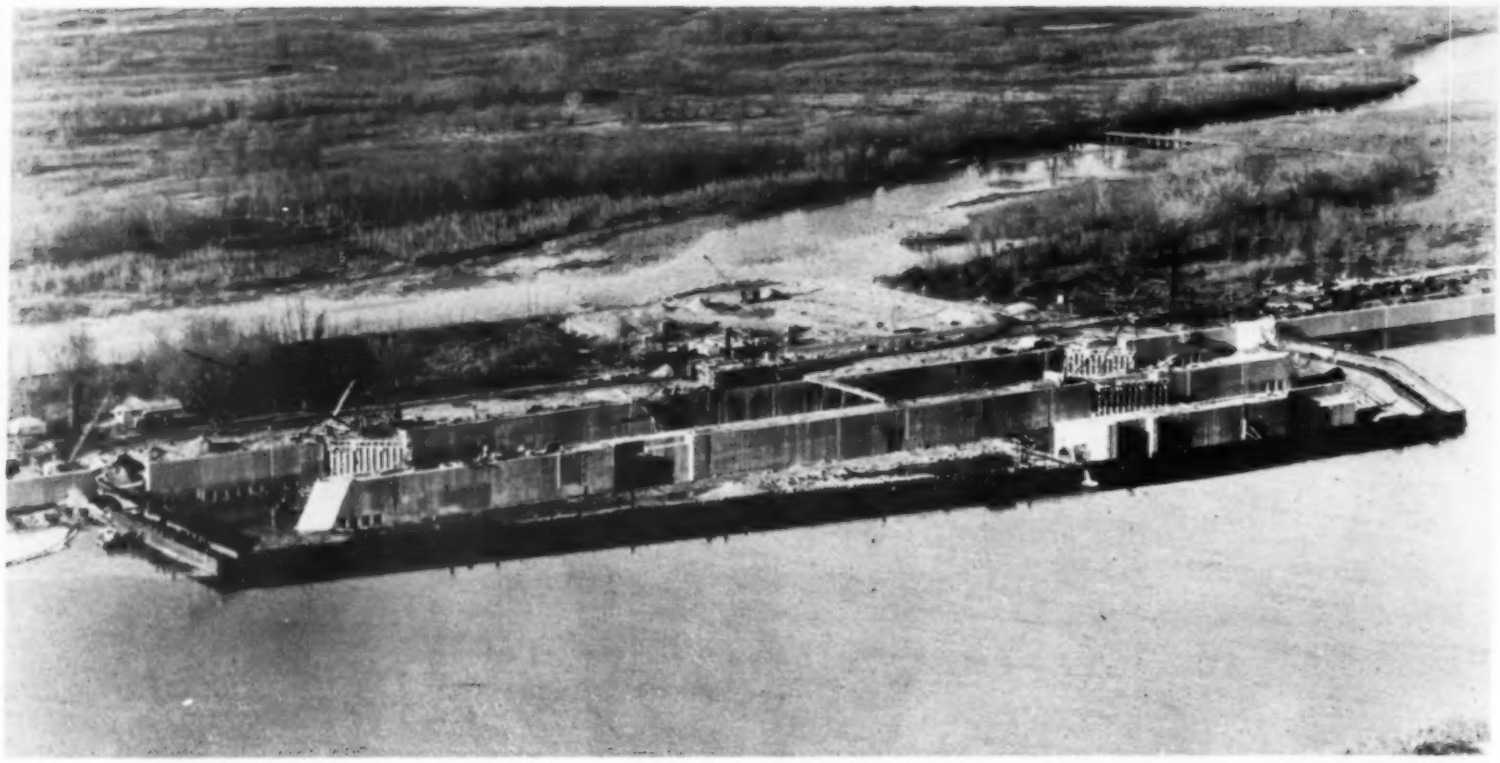

Mississippi Lock No. 5A, Winona, Minn. 1500 tons of Inland Section I-31 used for permanent cut-off walls; 1200 tons Inland Section I-22 for temporary cofferdam. Project also involved 360 tons of Inland Reinforcing Bars.

Inland Piling Used Extensively on Upper Mississippi Waterway

THE 9-foot channel now being constructed by the Government on the upper Mississippi River is one of the greatest waterway developments ever undertaken. Already, Inland Steel Sheet Piling has been used for 10 units of this vast project.

This Piling is driven in temporary construction for building huge cofferdams. It is also employed as permanent cut-off walls below the great locks and dams that are dotting the river between St. Paul and St. Louis.

The experienced engineers and contractors who design and build these projects are able and discriminating judges of materials. Their selection of Inland Steel Sheet Piling should recommend its use to you. INLAND STEEL COMPANY, 38 South Dearborn Street, Chicago, Ill.

A COMPLETE LINE:

Inland produces all of the nine standard American Steel Sheet Piling Sections.

USED PILING:

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Rails Track Accessories
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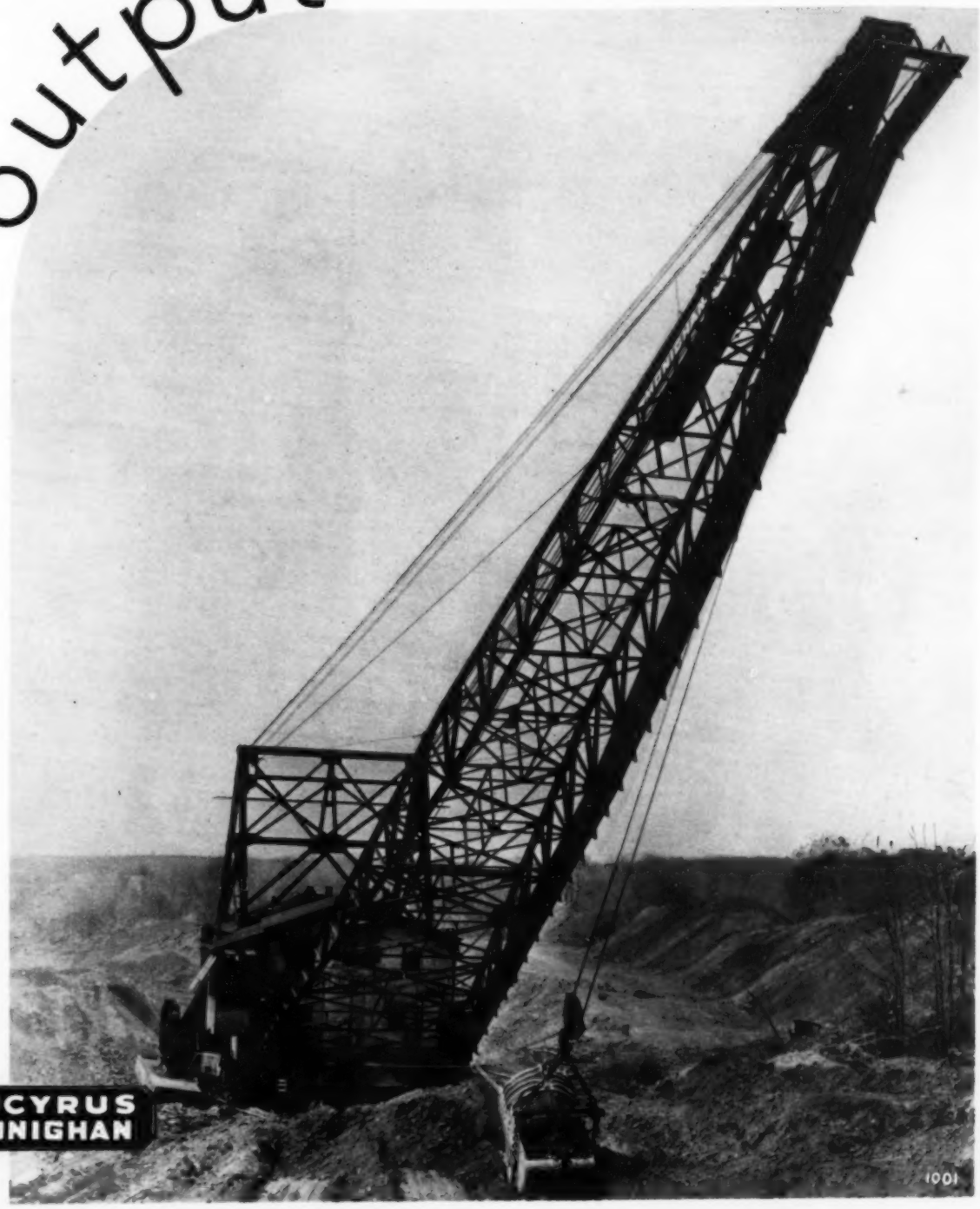
TURN moving time into digging time with Bucyrus-Monighan walking traction. Step out in any desired direction by simply pointing the boom . . . without loss of time. Walking traction is simple, strong, and moves the machine the quickest way over wet, soft, uneven ground, or around obstacles. And there's plenty of speed, power, and stamina in these Walkers to make the fullest use of the digging time gained with every move. Put Bucyrus-Monighans on your job and watch output figures go up! Manufactured by Bucyrus-Monighan Company, Chicago, Illinois.

output



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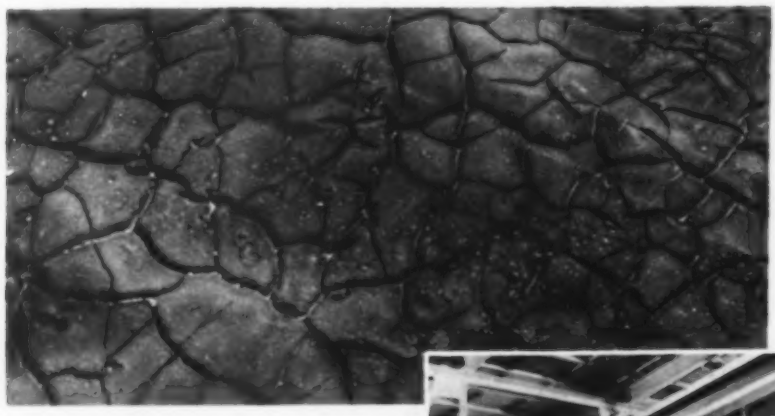
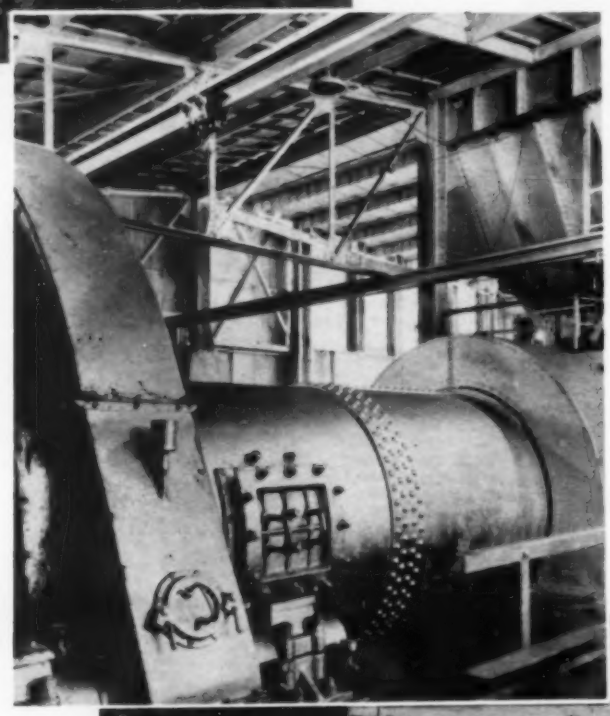
KOPPERS PRODUCTS PROTECT



WHAT HAPPENS WHEN ROOFING CRACKS?—Permanent cracking shortens the life of some types of roofing. Water from rain, hail and snow enters the cracks and spreads through the roofing. Eventually it enters the building. If you are to avoid these troubles, your roofings must have the ability to heal and seal themselves automatically when cracked. Photomicrographs at left show how Koppers Coal Tar Pitch Roofings healed themselves when cracked and how another type of roofing failed to heal under exactly the same conditions.

KOPPERS ROOFING	ANOTHER TYPE OF ROOFING
(As illustrated through microphotographs)	
	
1. Koppers Roof cut for test purposes. Cut extends down to first layer of felt.	1. First view of cut made in another type of roof.
	
2. After exposure to heat. (131°F. to 158°F., a temperature frequently found on roofs.) Pitch has already begun to move.	2. No material change.
	
3. Further movement of the pitch.	3. No material change.
	
4. Almost completely sealed. Note how the slag has followed the movement of the pitch.	4. No material change.
	
5. Complete fusion has now taken place. The layer of pitch is again continuous.	5. No material change.



A ONE-COAT PAINT JOB OVER OLD DARK PAINT. Koppers Lumino produces two protecting films with one application and one labor cost. Lumino is a chemically-processed tar base vehicle for aluminum powder. When applied, the tar base forms an impermeable, waterproof black film which prevents corrosion and the aluminum powder leafs to the surface to form an overlapping metal protection which completely conceals the black vehicle. This photograph shows Lumino applied to a cement mill which had long been painted a dark color.

A MODERN TAR ROAD IS COMPARATIVELY FLAT IN CROSS-SECTION—This photograph shows a Tarmac penetration surface in South Park, Allegheny County, Pa. Many people have a misconception of what a tar pavement can be, because they judge the tar road from old high-crowned surfaces. Tar roads, built comparatively flat and with good alignment and grade, are equivalent in riding qualities to the most expensive pavement. And tar surfaces can be maintained in that condition indefinitely at low expense.

KOPPERS

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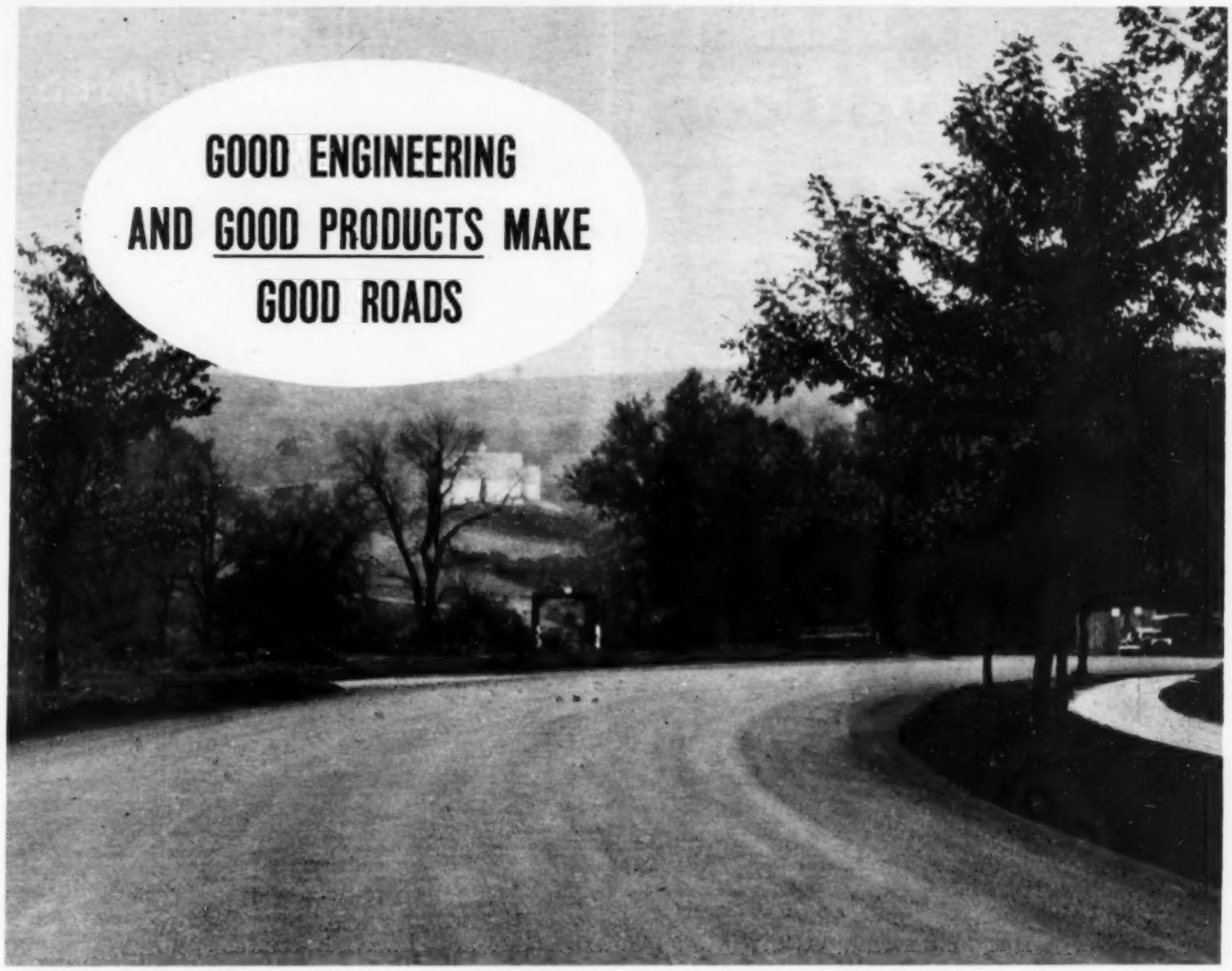

Standard Cut-Back Asphalt, Socony Brand, road mix construction in Tompkins County, near Cornell University Buildings, Ithaca, New York.

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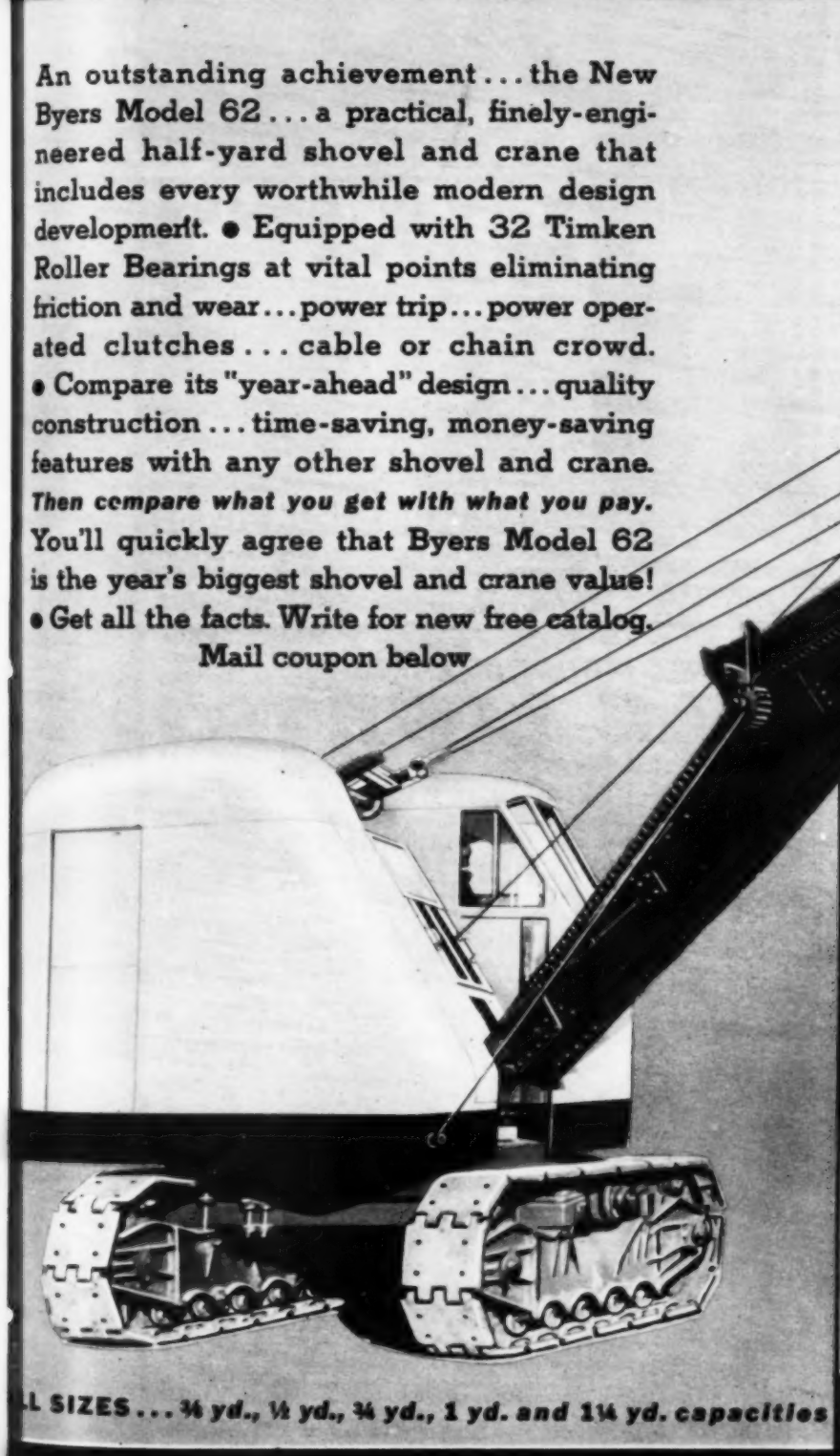
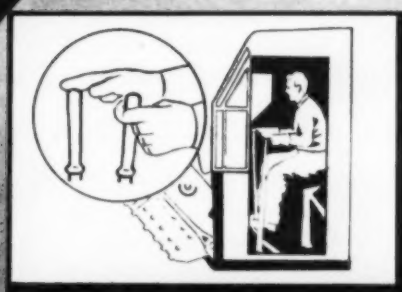
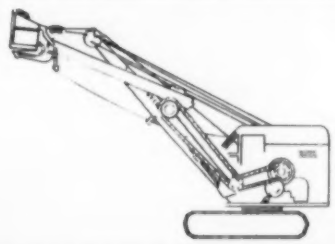
An outstanding achievement . . . the New Byers Model 62 . . . a practical, finely-engineered half-yard shovel and crane that includes every worthwhile modern design development. • Equipped with 32 Timken Roller Bearings at vital points eliminating friction and wear . . . power trip . . . power operated clutches . . . cable or chain crowd. • Compare its "year-ahead" design . . . quality construction . . . time-saving, money-saving features with any other shovel and crane. ***Then compare what you get with what you pay.*** You'll quickly agree that Byers Model 62 is the year's biggest shovel and crane value! • Get all the facts. Write for new free catalog. Mail coupon below



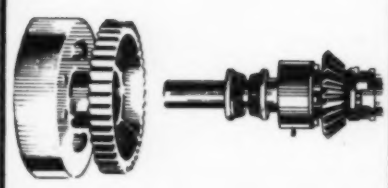
L SIZES . . . ¾ yd., ½ yd., ¾ yd., 1 yd. and 1¼ yd. capacities



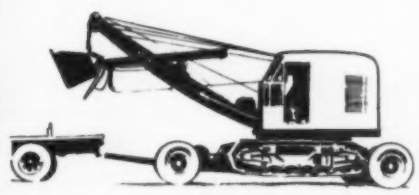
CLUTCHES—Newly designed crowd and swinging clutches cushion all shocks, yet are sensitive to the slightest touch. No chattering clutches . . . no jerky operation with Byers finger-tip controlled clutches.



CHAIN CROWD—Simplified independent chain crowd. Shipper shaft pinions are mounted on squared shafts which eliminate troublesome keys. Chain is self-adjusting to all boom angles.



CLUTCH—Roller or ring mounted crowd, travel and swing clutches . . . increase power . . . eliminate pushing wear that causes clutches to chatter . . . makes clutches easier to operate.

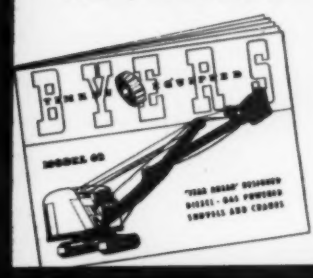


BYERS TRAILER—Equipped with dual pneumatic tires, Timken roller bearing mounted wheels, and manually or air applied Bendix Westinghouse brakes, this trailer increases your radius of profitable operation.

THE BYERS MACHINE CO.

RAVENNA, OHIO, U.S.A.

THE BYERS MACHINE CO. . . . Ravenna, Ohi



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YOUR INTERESTING BOO
Byers Catalog "62

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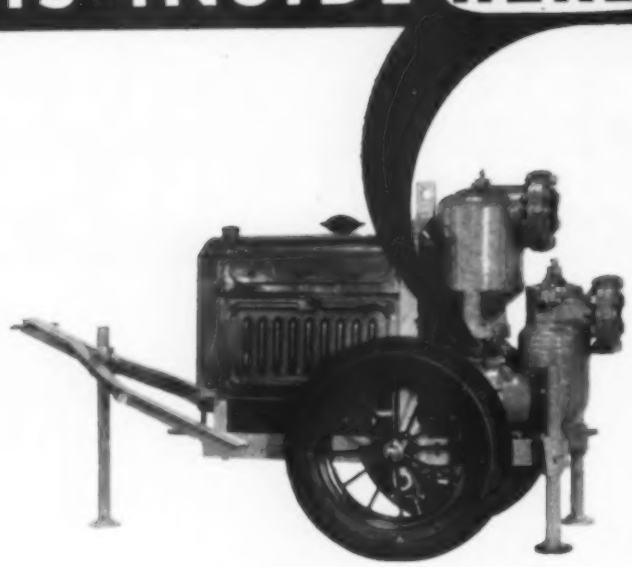
62-2

THE DIFFERENCE IS INSIDE *HERE*



LaBour Hydrobalance pumps for contractors' service incorporate the same exclusive features which have demonstrated their simple dependability on all sorts of jobs during the past dozen years. This company originated the self priming centrifugal pump, and the several imitations which have since been produced have been unable to surpass or even equal the standard of performance and effectiveness set by LaBour.

The patented principle of hydraulic balance is the only method which has ever been developed to stop unnecessary recirculation without the use of valves or other complex and troublesome apparatus. Other pumps have been made to look like LaBours externally, but it is what is inside the pump that counts, and there is the great difference.

No Auxiliary Parts

LaBour Pumps do not require any adjustment for priming under suction lifts of various heights. The capacity of a LaBour pump is unaffected by any increase in suction heads, as long as the total head remains the same. LaBour Pumps have no valves, floats, springs or other auxiliary parts to stick, wear, break and otherwise interfere with perfect operation.

We shall be glad to send you a copy of our Bulletin No. 41, which not only illustrates and describes our complete line of contractor pumps ranging in capacity from 50 to 1500 gallons per minute, but also provides a simple explanation of the exclusive Hydrobalance Pump, made only by LaBour.

THE LABOUR CO. INC.

309 Sterling Avenue, Elkhart, Indiana

QUINN PIPE FORMS

HAND or WET PROCESS

Make concrete pipe on the job with *Quinn Pipe Forms*. Gives employment AT HOME where it is needed. Quinn Pipe Forms can be handled by less experienced labor and produce uniform concrete pipe of highest quality.

HEAVY DUTY CONCRETE PIPE FORMS

Built to give more years of service—sizes for any diameter pipe from 12 to 84 inches—tongue and groove or bell end pipe—any length. Backed by years of service in the hands of contractors, municipal departments and pipe manufacturers.

NEW MEDIUM DUTY CONCRETE PIPE FORMS

Meet the demand for low cost equipment that produces a uniform quality of pipe in smaller amounts. Complete in every way. Stands up on any job. Same sizes as "Heavy Duty," from 12 to 84 inches—any length.

WRITE TODAY

Get complete information on prices and Special Construction features of Quinn Pipe Forms. Give us size of job for estimate on your pipe form needs.
Also manufacturers of concrete pipe machines for making pipe by machine process

QUINN WIRE & IRON WORKS

1625 TWELFTH ST. BOONE, IOWA

NATIONAL CARBIDE

V-G LIGHTS

Most Light from least Carbide Quickly Charged

Easily moved—No wires
No Burner Troubles

No waste Carbide whether used continuously or intermittently
No harm done if tipped over

Extension to X-100 DOUBLES THE CANDLE POWER *fastens anywhere*

Always use NATIONAL CARBIDE *"In the Red Drum"* Distributors Coast to Coast

WRITE FOR COMPLETE INFORMATION

X-100
NATIONAL CARBIDE V-G LIGHT
About 8,000 c.p. for 12 hours on 7 lb. charge of National Carbide. Easily handled by one man. Weight 35 lbs. empty; 98 lbs. full.

Y199
NATIONAL CARBIDE V-G HANDY LIGHT
Burns about 5½ hours on 1¼ lbs. of 14-ND Carbide, 2 gals. water; delivers about 1500 c.p. Weighs 37 lbs. charged—easy to carry, handy in emergencies.

WLI-C1
NATIONAL CARBIDE LANTERN
Burns 8 hrs. on 8 oz. of Carbide. Brilliant rear signal of red, blue or green, no extra charge . . . Ideal for emergency lighting on road at night.

NATIONAL CARBIDE SALES CORP.
LINCOLN BUILDING
Opposite Grand Central, NEW YORK

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Please send me your booklet, "A New Way to Ride on Rubber."
I am interested in Spongex Cushions for Tractors ☐ Road Machinery ☐ Trucks ☐.

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SPONGEX

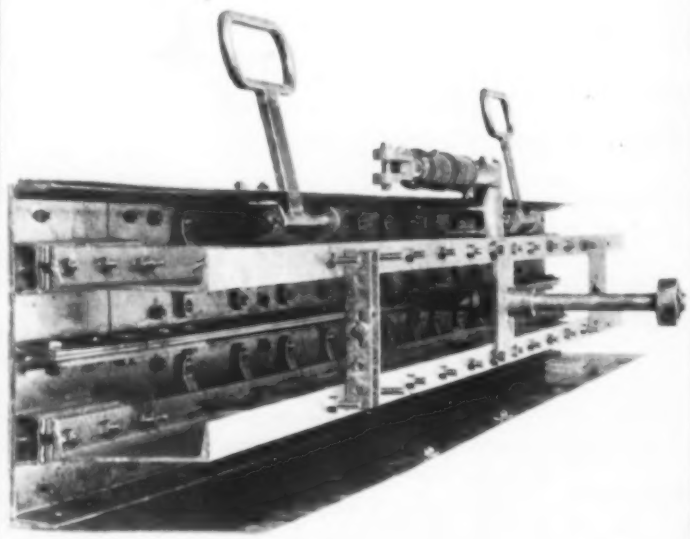
SPONGE RUBBER SEAT CUSHIONS

SADDLE OR BOX TYPE

Provide a cushion for every seat. Spongex Cushions are all sponge rubber construction. They last far longer than spring cushions and give superior riding ease and protection.

SPONGE RUBBER PRODUCTS CO.
DERBY, CONNECTICUT

SOMETHING NEW IN SCREEDS



The above rotogravure shows the FLEX-PLANE screed-attachable to their finishing machine or joint machine. Its great width, together with its weight, prevents matrix from passing under it; consequently, extremely level surfaces have resulted. It is adjustable and the crown may be changed at intervals of one foot.

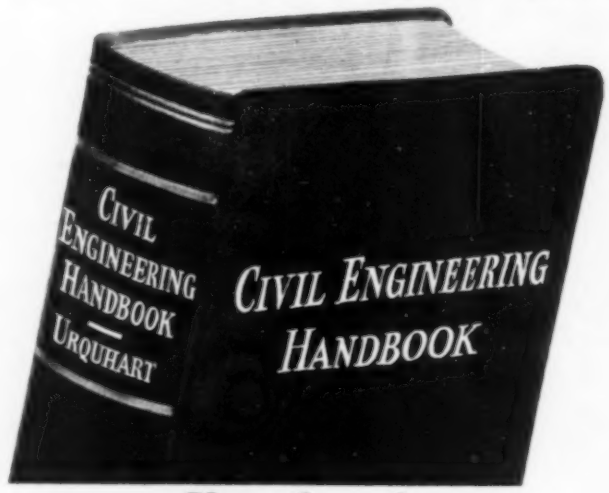
The starter springs store pressure and help start the screed in the opposite direction; they also minimize any sidesway.

FLEXIBLE ROAD JOINT MACHINE CO.
Warren, Ohio

10 basic treatises

covering the entire field of civil engineering—emphasizing material needed by engineers—presenting adequate and usable treatments of essential topics.

In one new handbook at the low price of $5.00



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CIVIL ENGINEERING HANDBOOK

By Leonard C. Urquhart, *Editor-in-Chief*
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UP-TO-DATE, authoritative, new in approach, this book makes available to civil engineers a manual of unusual value. In one volume it presents the fundamentals of the various subdivisions of civil engineering, for the use of practicing engineers, especially when confronted with problems outside their specialized fields. In each division a noteworthy specialist has contributed a compact treatise, developing fundamental theories as well as stating more involved ones, making the book not only a comprehensive reference work, but also adaptable for systematic study of any of the fields represented in it.

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3. Mechanics of Materials
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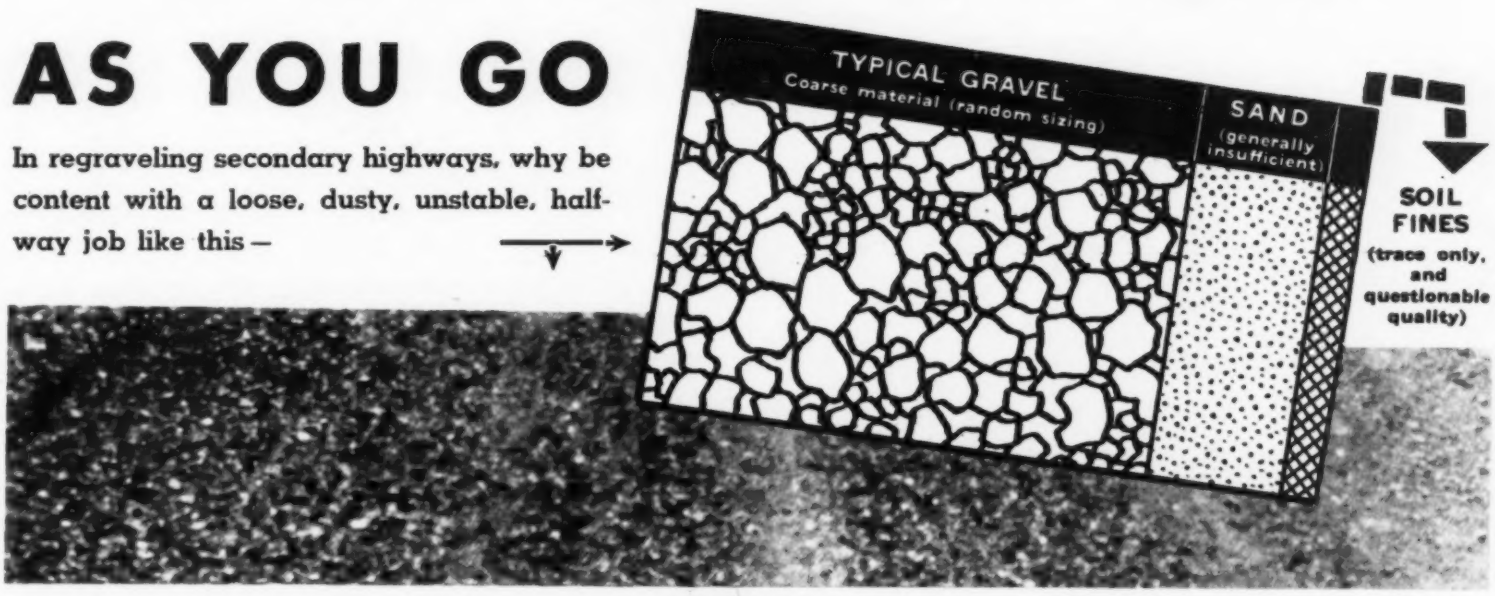
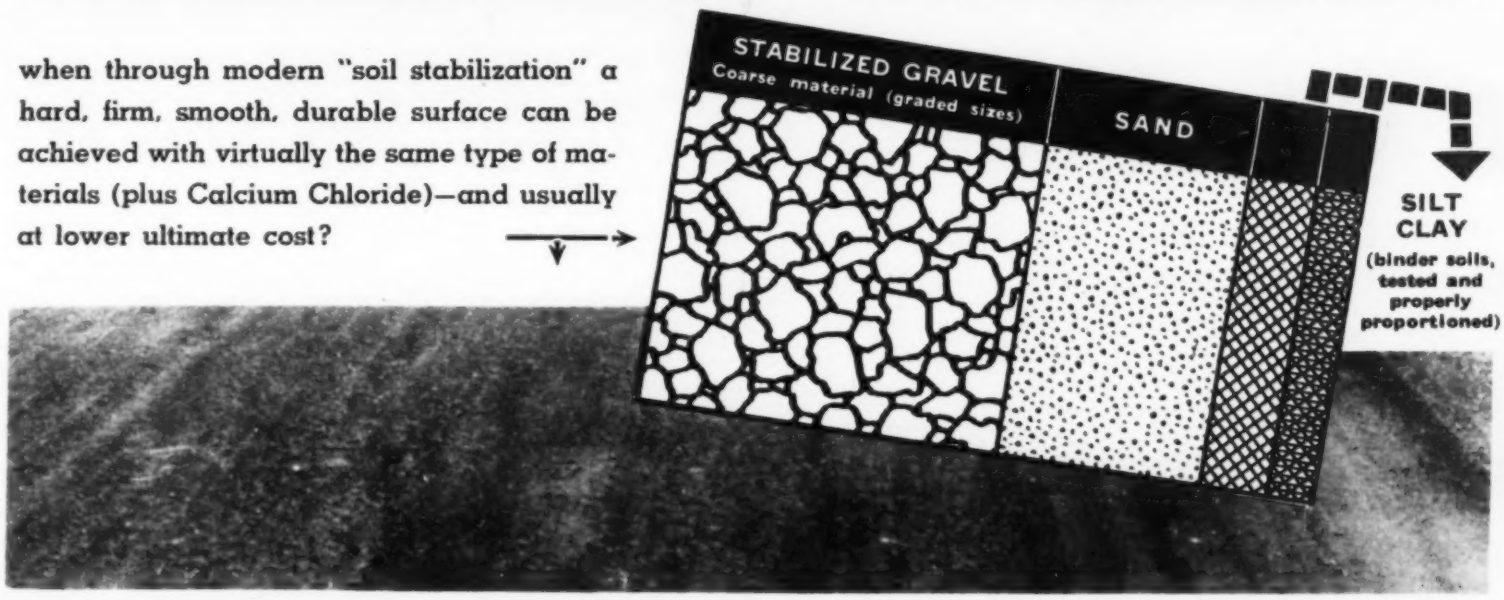
"STABILIZE"

AS YOU GO

In regraveling secondary highways, why be content with a loose, dusty, unstable, halfway job like this—



when through modern "soil stabilization" a hard, firm, smooth, durable surface can be achieved with virtually the same type of materials (plus Calcium Chloride)—and usually at lower ultimate cost?



SOIL STABILIZATION **— what it is, does and saves:**

1 Enables gravel (or slag or stone) to be readily compacted through properly graded and properly proportioned sizings.

2 Enables such gravel to be thoroughly bonded with proper proportions of sand, clay and silt KEPT MOIST WITH CALCIUM CHLORIDE.

3 Produces a smooth, dustless, durable surface mat whose service value and traffic capacity are in direct relation to the proper gradation and mixture of materials.

4 Provides all-weather stability; minimizes maintenance and material losses; produces an excellent foundation for future paving.

5 Low in cost—thereby enabling immediate improvement of the greatest number of miles of road.

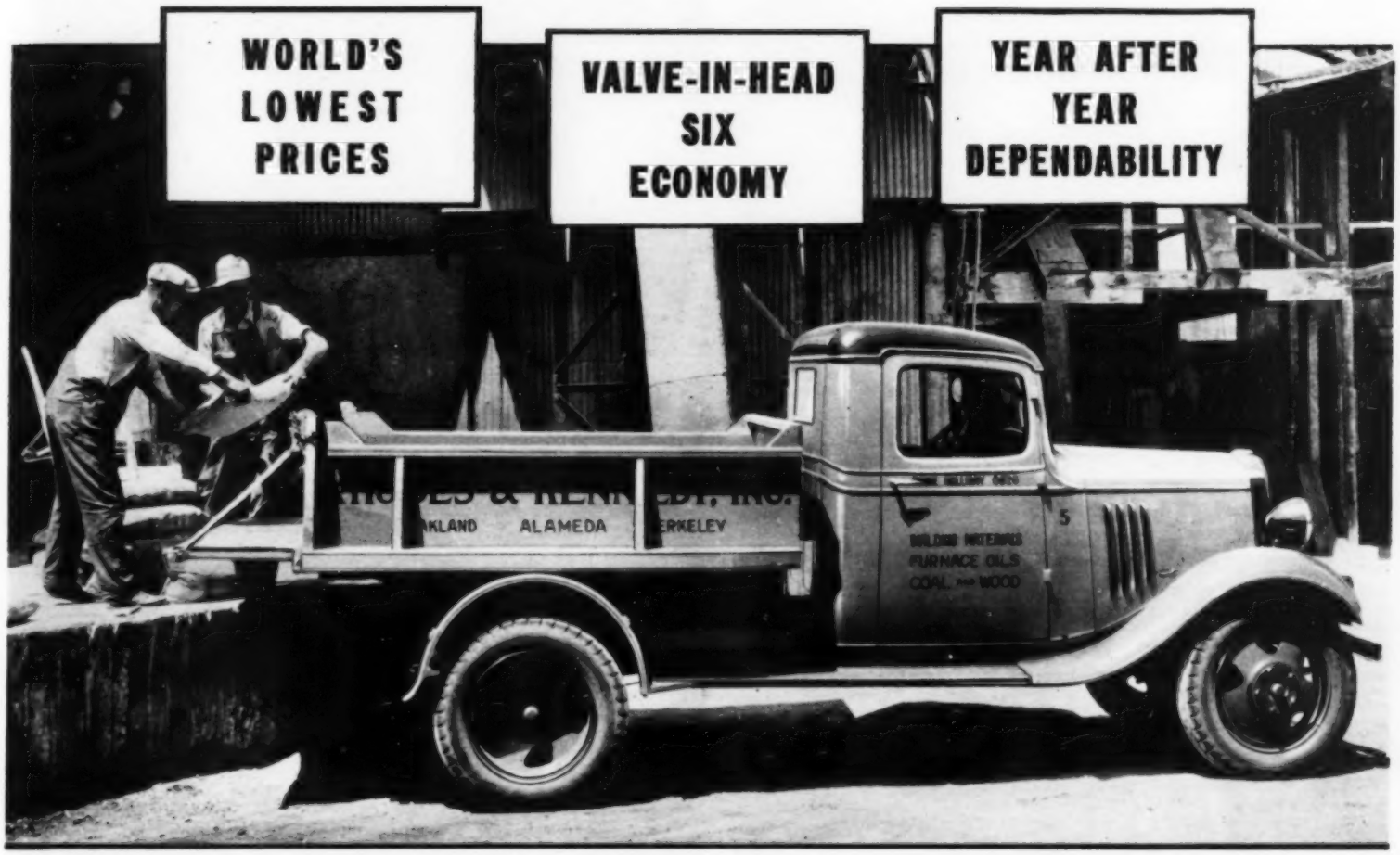
Learn—at once—about this modern, thoroughly proved, and now widely used method of low-cost secondary-highway improvement. For free literature address any of the following members of the CALCIUM CHLORIDE ASSOCIATION:

Michigan Alkali Company . . . 60 E. 42nd St., New York City
Solvay Sales Corporation . . . . 40 Rector St., New York City
The Dow Chemical Company . . . . . Midland, Michigan
The Columbia Alkali Corporation . . . . . Barberton, Ohio

CALCIUM CHLORIDE

FOR STABILIZING ROAD SURFACES

IT PAYS 3 WAYS TO BUY CHEVROLETS



CHEVROLET Today, when every wise buyer of trucks is particularly interested in getting dependable transportation at lowest cost, the money-saving advantages of Chevrolet Trucks have a particularly strong appeal. Truck buyer after truck buyer is discovering that *it pays three ways to buy Chevrolets.* And truck buyer after truck buyer is deciding to take advantage of the big savings which Chevrolet offers. You, too, will get *better haulage service at lower cost* by buying a Chevrolet Truck because of these triple economies:

1. **Chevrolet Trucks sell at the world's lowest prices.**
2. **They use less gasoline and oil because they are powered by six-cylinder valve-in-head engines.**
3. **They give longer, more dependable service because of the *extra quality* which Chevrolet builds into every part of its products.**

Visit your nearest Chevrolet dealer—*this week.* Have a thorough demonstration of the right Chevrolet Truck for your haulage needs. Buy a *Chevrolet* and get better truck performance at the *world's lowest prices!*

CHEVROLET MOTOR COMPANY, DETROIT, MICHIGAN

Compare Chevrolet's low delivered prices and easy G.M.A.C. terms. A General Motors Value

CHEVROLET TRUCKS

A Half Mile Dive
on a life-line of steel

TO MAKE CERTAIN that Roebling Wire Rope will give the user the highest obtainable degree of safe, economical service, Roebling has enlisted the aid of the finest and most complete research, testing and manufacturing facilities. Roebling Equipment for making acid open-hearth steel wire is an example. John A. Roebling's Sons Company, Trenton, N. J. Branches in Principal Cities.

DR. WM. BEEBE'S & MR. OTIS BARTON'S WORLD-RECORD DIVE OF 3,028 FEET

Last August, in a great 2½ ton steel ball, 1½ inches thick...over one-half mile below the surface of the sea, off Bermuda...these famous and courageous naturalists peered through 3 inch thick fused quartz windows at a wonderland of sea-life.

Each window alone held back over 19 tons of water. A terrific total pressure of over 7000 tons strove to make a broken egg-shell of their cast-steel "laboratory." And linking them to the world above was a solitary slender life-line of steel...a Roebling Wire Rope.

For all three of his great "Bathysphere" oceanic expeditions, Dr. Beebe has staked safety on the strength and stamina of Roebling "Blue Center" Steel Wire Rope.

DRAWING FAMOUS ROEBLING ACID STEEL WIRE

Acid Steel Wire, famous for its uniformity and fatigue-resistance, is the basis of Roebling "Blue Center" Wire Rope.

HOISTING WORLD'S LARGEST PIPE SECTIONS

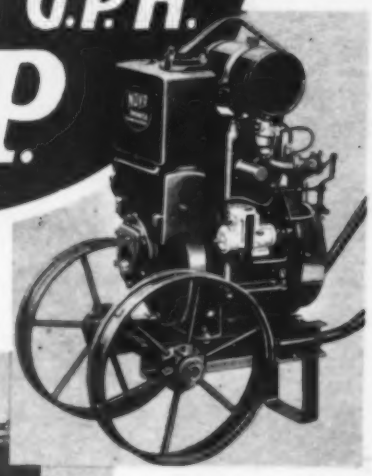
Roebling "Blue Center" Wire Rope Slings are used for hoisting 90 ton sections of pipe, 30 feet in diameter, at Boulder Dam.

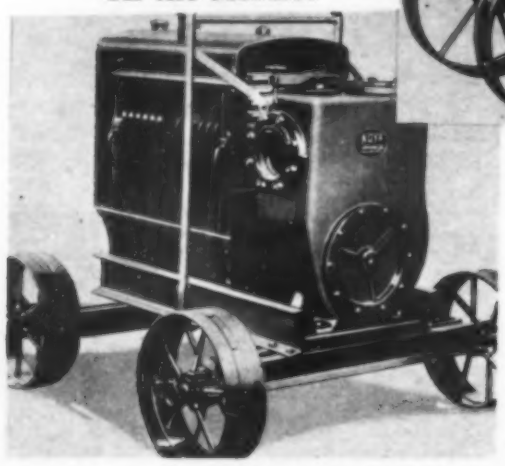
ROEBLING ...THE PACEMAKER IN WIRE ROPE DEVELOPMENT

$115 ON SKIDS
$125 ON WHEELS
10,000 G.P.H.
3 H.P.

NOVO 2" SELF-PRIMER

The Best Pump Buy on the Market





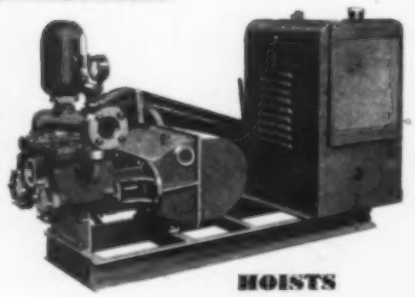
The line of Novo Self-Priming Centrifugal Pumps—The highest powered, most efficient, Self-Primers made.

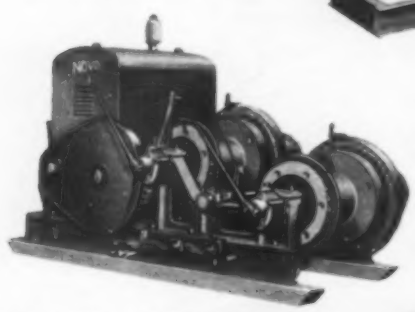
2" . . . 10,000 GPH
3" . (20,000 GPH
(24,000 GPH
4" . . . 40,000 GPH
6" . . . 90,000 GPH

PRESSURE PUMPS

Single and Duplex, Double Acting 40-500 pounds pressure 15-110 G P M.

They will cut your pumping costs.





HOISTS

A complete line, from 1000 to 15,000 pounds capacity. Incorporating the latest most practical features of hoist design. Also Novo Dragline Hoists—approved the world over.

SEND THE COUPON FOR FULL INFORMATION
THERE IS NO OBLIGATION

PUMPS · HOISTS AND ENGINES
NOVO ENGINE COMPANY
LANSING, MICHIGAN U.S.A.
LIGHT PLANTS · STARTING UNITS

NOVO ENGINE CO.
214 Porter St., Lansing, Mich.

Self-Priming Centrifugal Pumps
Pressure Pumps
Hoists Light Plants Dragline Hoists

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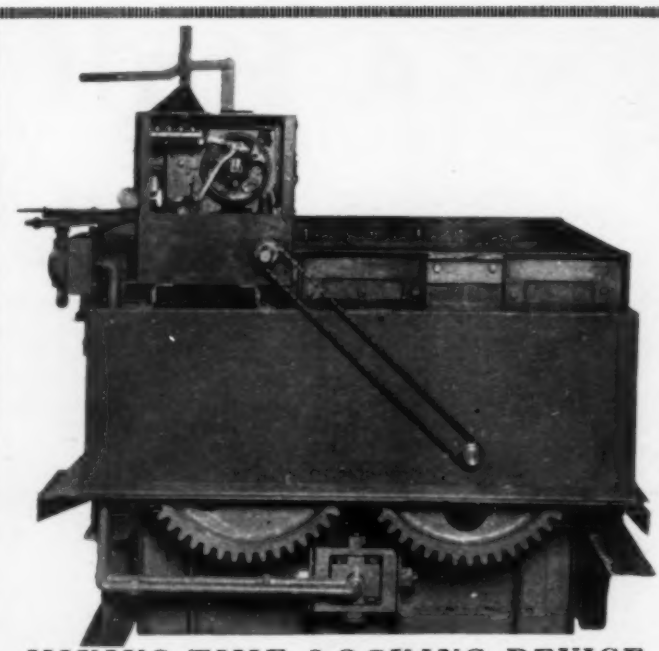


MIXING TIME LOCKING DEVICE

For asphalt mixers—Mechanically operated—Meets State Highway specifications—Applicable to any plant—Many now in operation—

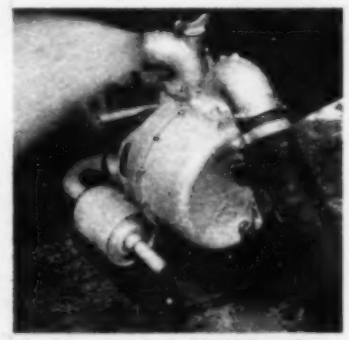
Send for Bulletin T-12

HETHERINGTON & BERNER, Inc.
INDIANAPOLIS, INDIANA

Builders of Asphalt Paving Machinery for over thirty years

QUICK Pump-Outs

93 lb Portable PUMP HANDLES 15,000 Gals. Per. Hr.



With the new Homelite 3" portable, self-priming, centrifugal pump you can often have a job all pumped out in the time required for getting an ordinary pump set up. This unit weighs only 93 pounds complete with built-in gasoline engine. A man can easily carry it wherever needed. 15,000 gallons per hour. One gallon gas pumps 35,000 gallons of water. Built to handle muddy water heavy with solids. Guaranteed 28-foot suction lift. Self-priming. Water proof, hot-spark magneto insures instant starting. Air cooled engine will not freeze or overheat.

Thousands of contractors and builders are cutting costs with handy Homelite Pumps (made in two sizes; 2", 7500 gal. capacity; and 3", 15,000 gal. capacity.)

Write today for illustrated bulletins.

HOMELITE Corporation
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HOMELITE Corporation
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Please send me bulletins describing Portable Pump.

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THE MICHIGAN TRUCK SHOVEL

Uniquely designed to meet the great demand for a power shovel that travels rapidly under its own power, the Michigan Truck Shovel offers the contractor and road builder an ideal tool with which he can efficiently handle jobs too large to shovel by hand and too small for a larger and less mobile machine. Speeds up to twenty miles—ready for work at all times—one engine furnishes power for transportation and digging. Write today for new bulletin.

MICHIGAN POWER SHOVEL COMPANY
Benton Harbor Michigan

MICHIGAN SHOVEL
for use on

- Highway Maintenance
- Fills
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- Industrial Work
- Scrap Material Yards
- Lumber Yards
- Retail Coal Yards
- Basement Excavating
- Gravel Pits and Stone Quarries
- Pipe Line Laying

Judge them by PERFORMANCE!

They "have everything" is what users of Baker Bulldozers are saying. Performance counts. Direct lift, perfect smooth control, great strength combined with other brand new features make them the first choice of leading contractors.

Ask For Bulldozer Bulletins

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568 Stanford Ave. Springfield, Ill.

TWIN-CYLINDER **BAKER** DIRECT-LIFT
BULLDOZERS

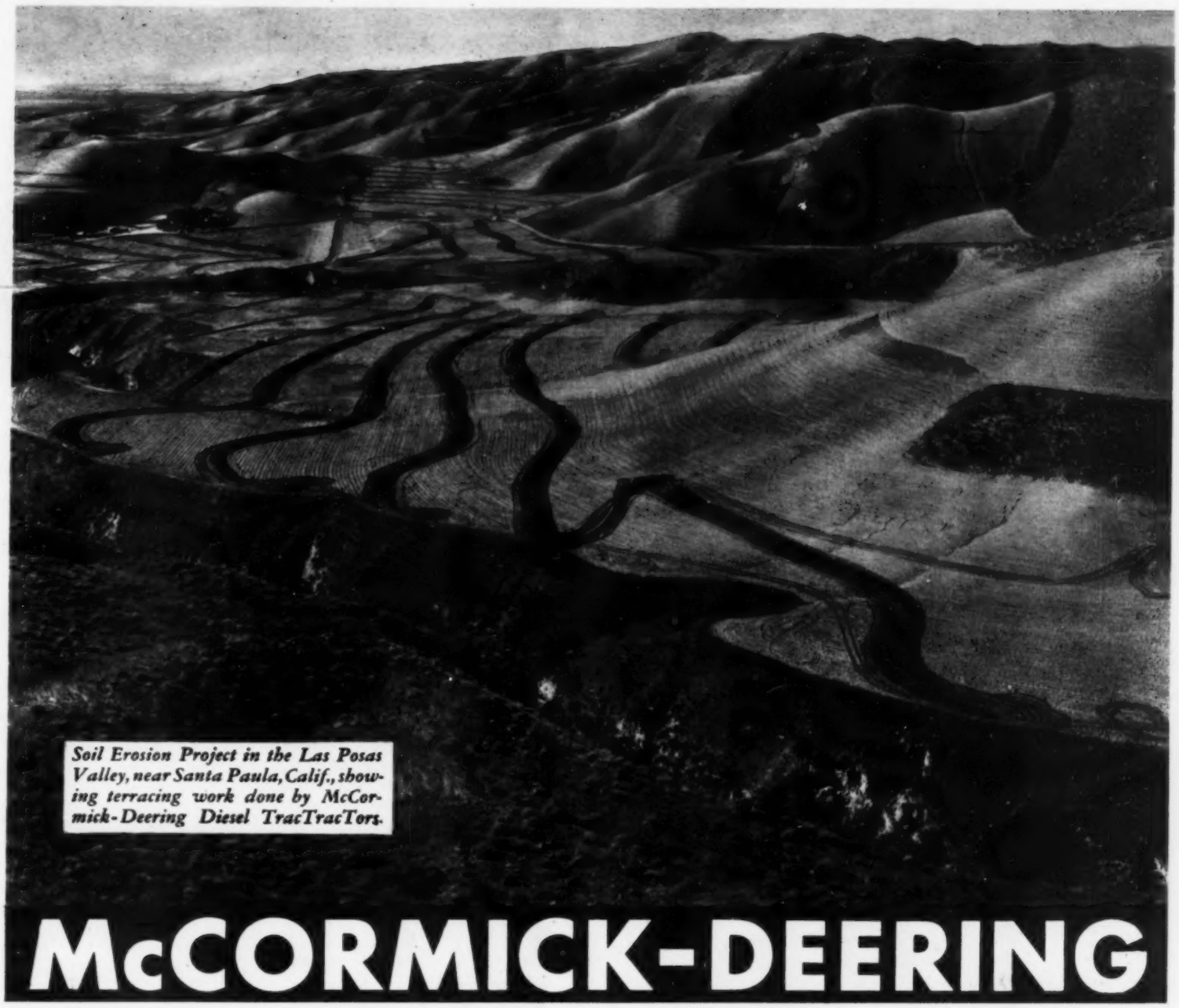
Good Roads

CHAMPION
ROLLER-BEARING ROCK CRUSHERS
Completely Portable
CRUSHING—SIZING—LOADING PLANTS—FOR STONE OR GRAVEL

CRUSHING SCREENING FEEDING ELEVATING CONVEYING AND WASHING EQUIPMENT

Portable and Stationary plants engineered and built to give desired production requirements

Products of
GOOD ROADS MACHINERY CORP.
"Builders of Rock Crushers for 41 years"
KENNETT SQUARE PENNSYLVANIA



Soil Erosion Project in the Las Posas Valley, near Santa Paula, Calif., showing terracing work done by McCormick-Deering Diesel TracTracTors.

McCORMICK-DEERING

BUILDS TERRACES -- LEVEES -- ROADS

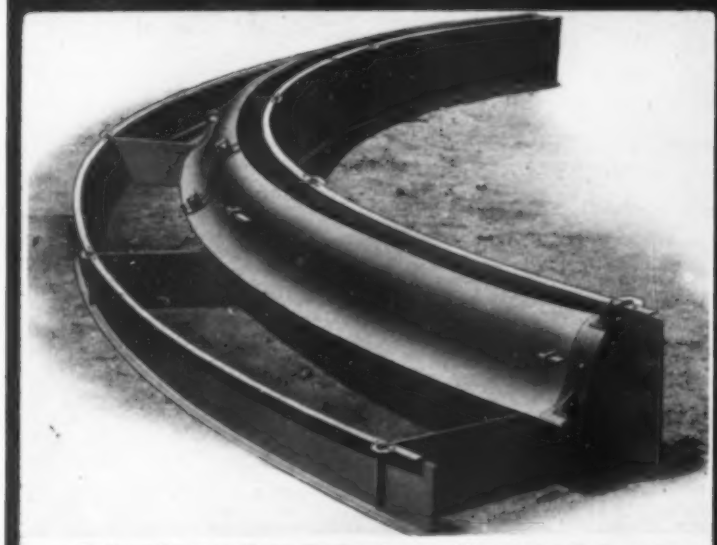
THE all-around ECONOMY in McCormick-Deering Industrial Power is backed by 30 years of experience in this field by the world's largest tractor builder—International Harvester—and by the network of distribution and service maintained by International Harvester. Exceptional economy is gained by exclusive McCormick-Deering design which makes the TracTracTors by far the *most accessible, most easily serviced* crawler tractors on the market. This product means go-getting efficiency and low-cost operation and maintenance. Thousands of McCormick-Deering TracTracTor and Wheel Tractor installations prove it for the past and guarantee it for your immediate future.

McCormick-Deering Diesel, as well as kerosene and gasoline, tractors and power units are available for all industrial needs. Consult our industrial power distributors or International Harvester branches. Specific information by mail, on request.

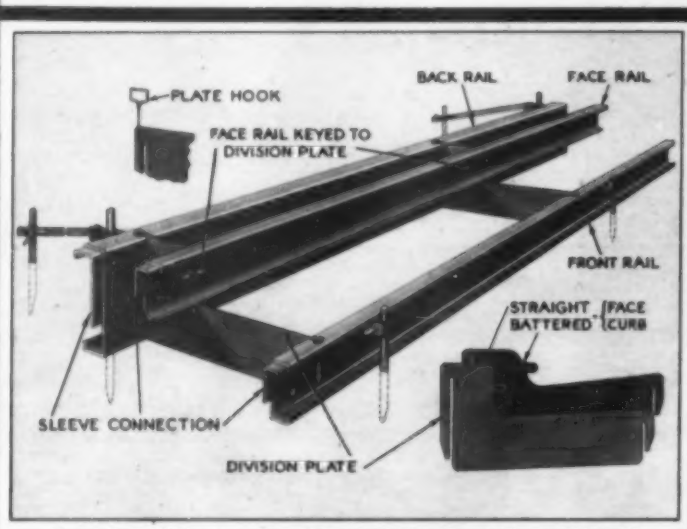
INTERNATIONAL HARVESTER COMPANY
606 So. Michigan Ave. OF AMERICA (Incorporated) Chicago, Illinois

DIESEL TRACTRACTOR

HELTZEL
STEEL FORMS
for Curb and Gutter



Curb-and-gutter Rigid Radius Form with special S-shaped face form.



Complete 10-foot section Heltzel Utility Forms for combined Curb-and-Gutter construction.

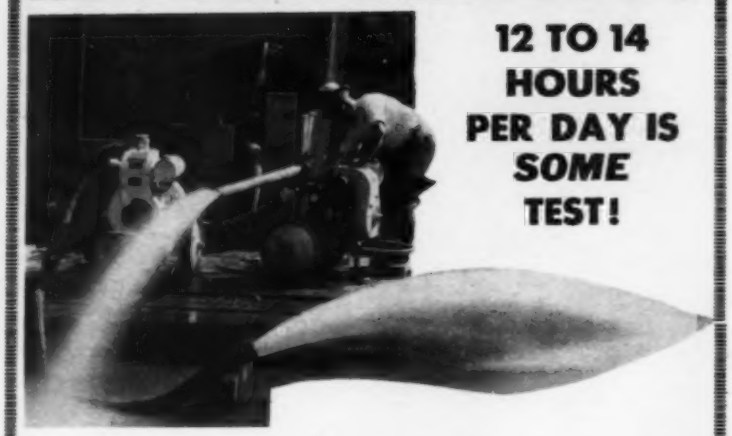
HELTZEL Rigid Radius Forms are made to any specifications for sidewalk, curb or combined curb-and-gutter construction, for producing uniform corner intersections.

HELTZEL Utility Forms are designed for use on any kind of subgrade and produce uniform concrete with dense, smooth surface, and give lasting economical service.

WRITE for Bulletin 200, describing the complete line of Heltzel Steel Forms for street construction use.

THE HELTZEL STEEL FORM & IRON CO.
WARREN, OHIO

Mr. W. S. Rae Knows PUMPS
READ HIS INTERESTING LETTER



12 TO 14 HOURS PER DAY IS *SOME* TEST!

W. S. RAE, Gen. Contractor, Pittsburgh, Pa., writes—

"We purchased four Sterling Quality Model MG Pumps for use at Reading, Pa., and later two more for Columbus, Ohio. We have used them 12 to 14 hours per day and longer. We find them economical and dependable."

The above illustration shows two of these pumps in action. If you are interested in the same dependable and economical service write for the big new Sterling Catalog.

Sterling
MACHINERY CORPORATION
111-13 Southwest Blvd. Kansas City, Mo.

BLAW-KNOX CONSTRUCTION EQUIPMENT

MODERN EQUIPMENT—Always Kept Up to Date for Better—Faster and Cheaper Work

The merits of Blaw-Knox Construction Equipment are fully recognized by contractors who are able to "low bid" on competitive jobs, fulfill all specifications and end up with a reasonable profit.

BLAW-KNOX COMPANY 2086 Farmer's Bank Building, Pittsburgh, Pa.
Offices and Representatives in Principal Cities

HEADQUARTERS FOR CONSTRUCTION EQUIPMENT SINCE 1906"

LAY-SET *Preformed* BREAKS THE RECORD

On this giant McMyler coal dumper 1¼" LAY-SET Preformed is used on the cradle of the dumper. And true to LAY-SET tradition it broke the record for wire rope performance. Here is that record:

Competitive Rope "A" . . .	*1,200,000 tons*
Competitive Rope "B" . . .	*500,000 tons*
Competitive Rope "C" . . .	*2,100,000 tons*
Competitive Rope "D" . . .	*1,505,561 tons*

LAY-SET PREFORMED • 3,448,498 TONS

Said the Superintendent: "On recent examination there was only one broken wire throughout the four lengths. In certain sections which came in constant contact with the sheaves the rope was worn down to 1" diameter, showing an even wear of the metal."

This is just typical of the remarkable service LAY-SET Preformed has been giving thousands of wire rope users *for years.* Investigate the many advantages LAY-SET Preformed can give *you.* Write today for rope engineering counsel.

HAZARD WIRE ROPE COMPANY
Wilkes-Barre, Pennsylvania
An Associate Company of the American Chain Co., Inc.
In Business for Your Safety

New York Pittsburgh Chicago
Birmingham Denver Los Angeles
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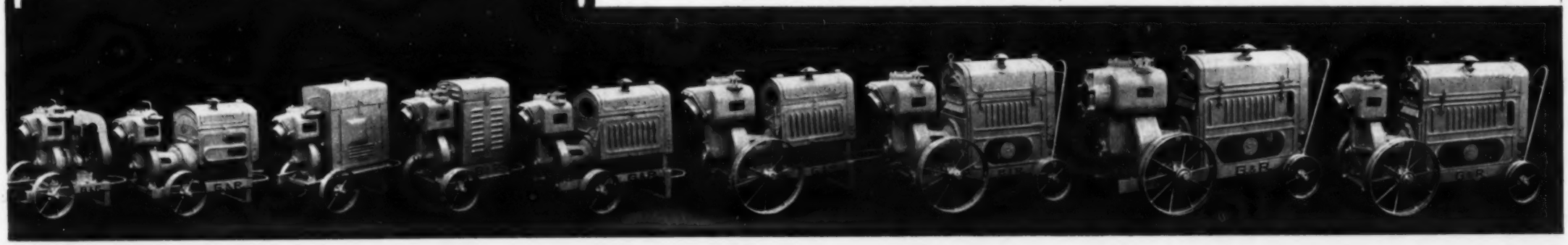
Fort Worth Tacoma

HAZARD LAY-SET *Preformed* WIRE ROPE

G&R PUMPS

GET RESULTS with GORMAN RUPP



Self Cleaning, Self Priming, Centrifugal Drainage Pumps.. Lowest Prices! Why Pay More?

Compare the prices with all others, then compare the pumps

COMPARE THEM BY ANY STANDARD OF COMPARISON—

Priming Time — Suction Lift — Capacity — Total Head — Ability to handle more and larger solids without clogging — 2″, 3″, 4″, 6″, 8″ Sizes.— Capacities 10,000 G. P. H. to 150,000 G. P. H. .

COMPARE THE DESIGN OF EACH PUMP FOR—

SIMPLICITY—The absence of gadgets and unnecessary parts.

STURDY CONSTRUCTION—Size of shafts, bearings, etc.

DEPENDABLE PERFORMANCE — Due to simplicity and sturdy construction.

LOWEST OPERATING COSTS — Because of highest pump efficiency.

LOWEST MAINTENANCE COSTS — Because of simplicity and strength of parts.

EASIEST HANDLING — Lightest weight because of elimination of useless chunks of cast iron.

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Get rid of the "Needle's Eye"

with these New

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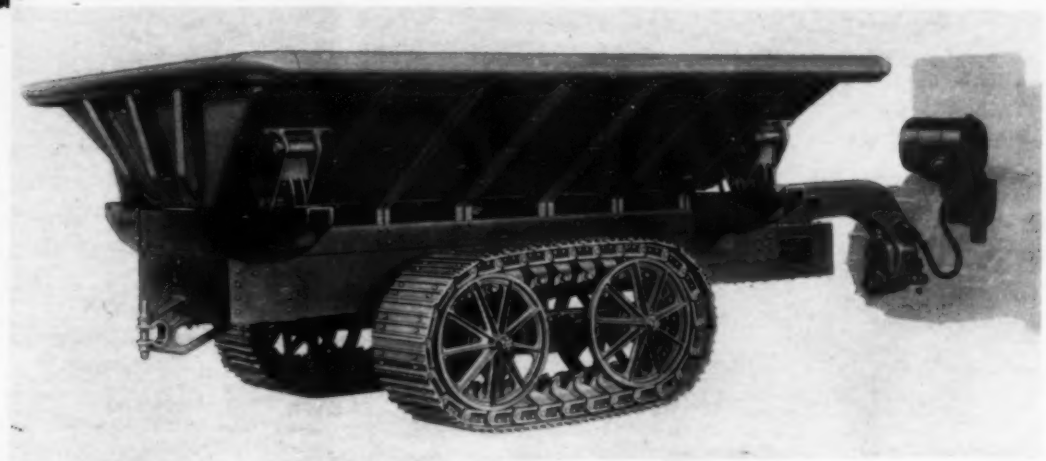

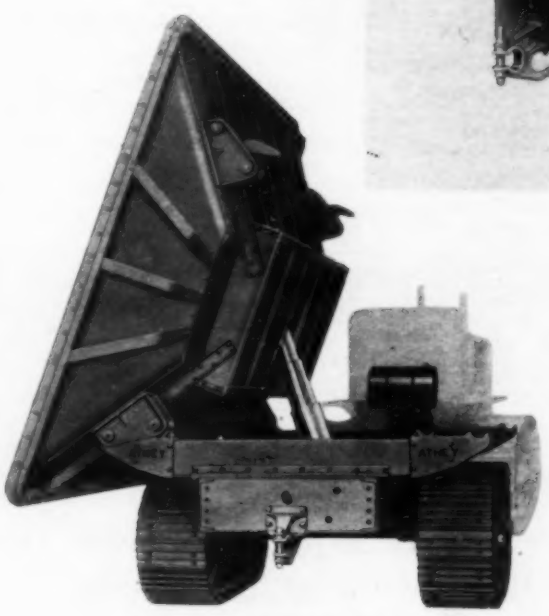

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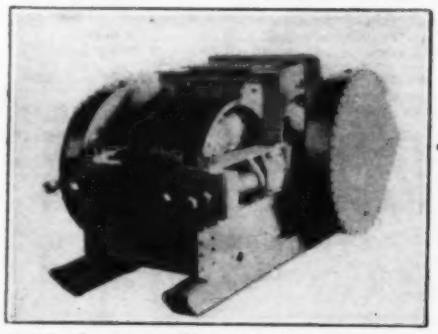
new

Symons-Cedar Rapids vibrator screen for Cedar Rapids portable plants.

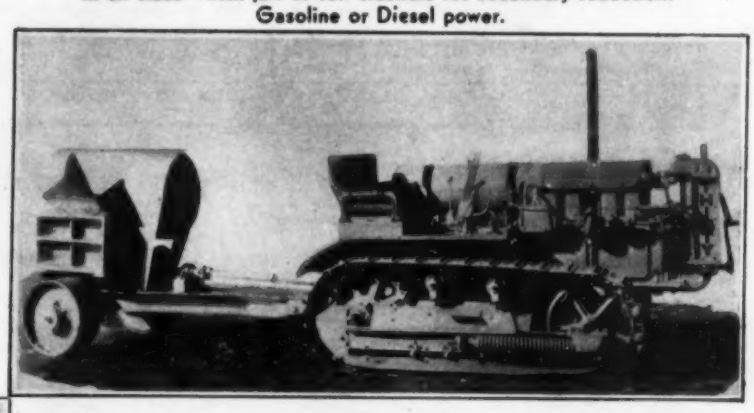
Tandem Straight Line portable plant with vibrator screen. Available in all sizes—with jaw or roll crushers for secondary reduction. Gasoline or Diesel power.

Pictured here are six new and important additions to the Cedar Rapids line. Equipment to meet every crushing, screening, or material handling requirement. Write for descriptive circulars on any equipment in which you may be interested.

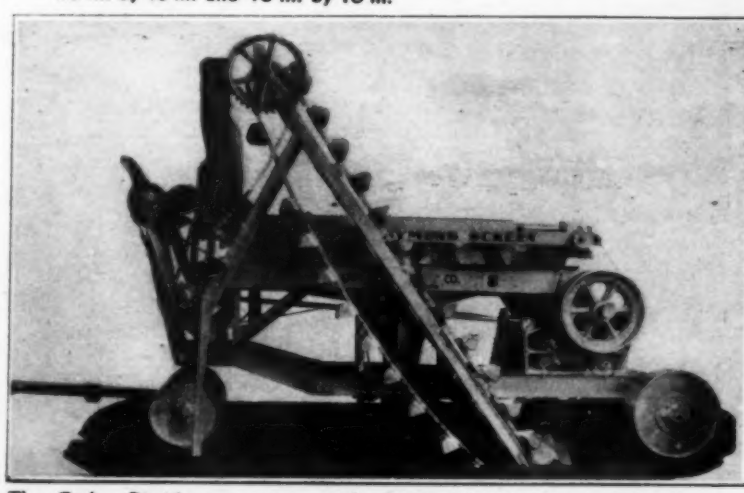


40 in. by 20 in. Cedar Rapids roll crusher. Made in two other popular sizes— 30 in. by 18 in. and 16 in. by 16 in.

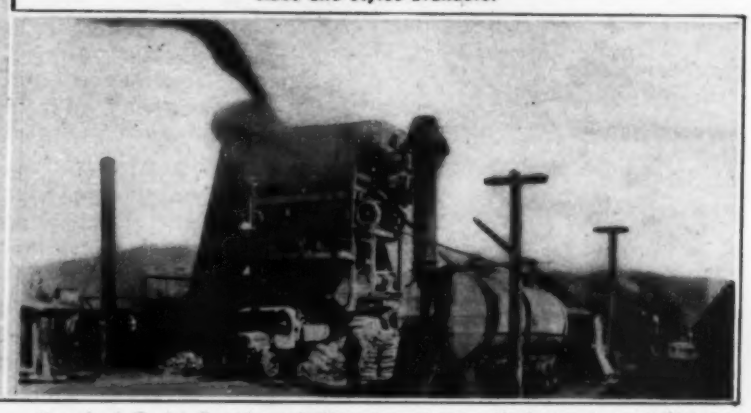
More Complete Than Ever Before



Tractor-trailor conveyer unit for roadside operation. Many other sizes and styles available.



The Cedar Rapids one piece outfit equipped with the new Symons vibrator screen — for greater capacity and efficiency. Ask us about the "Symons Changeover Plan" for present plants with rotary screens.



Standard-Cedar Rapids asphalt paving plant. Made in sizes with 500 to 5000 pound twin pugmills. Batch type plants with dryers, electric timing and locking devices — meets the most rigid state specifications.

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. . . INCREASED SERVICE
. . . CUT ROPE COSTS 75%
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